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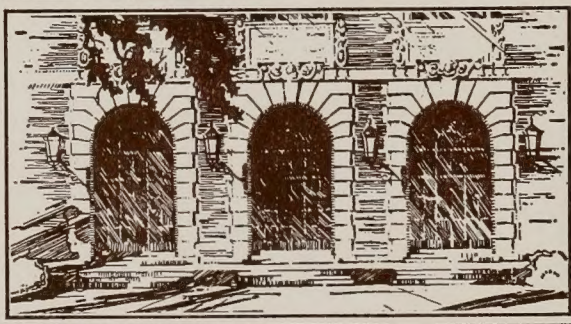
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ILLINOIS NATURAL HISTORY SURVEY

Bulletin

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Contents Volume 29 1965-1968

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION
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WILLIAM C. STARRETT
ARNOLD W. FRITZ

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ILLINOIS NATURAL HISTORY SURVEY
Bulletin

Volume 29, Article 1
March, 1965



Printed by Authority of
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A Biological Investigation of the Fishes
of Lake Chautauqua, Illinois

WILLIAM C. STARRETT
ARNOLD W. FRITZ

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
NATURAL HISTORY SURVEY DIVISION
Urbana, Illinois

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This report is printed by authority of the State of Illinois, IRS Ch. 127, Par. 58.12. It is a contribution from the Section of Aquatic Biology of the Illinois Natural History Survey.

The fishing investigation reported in this paper was done as a cooperative project of the Illinois Natural History Survey, the Illinois Department of Conservation, and the U. S. Fish and Wildlife Service. Some funds from D-J Project F-14-R were used in preparing the manuscript. William C. Starrett, Aquatic Biologist with the Natural History Survey, was in charge of the investigation. Arnold W. Fritz, Fisheries Biologist with the Illinois Department of Conservation, was assigned to the Natural History Survey in 1956.



A Biological Investigation of the Fishes of Lake Chautauqua, Illinois

WILLIAM C. STARRETT
ARNOLD W. FRITZ

THIS PAPER is based on a 10-year biological investigation of the fishes of Lake Chautauqua, a lateral-levee reservoir of approximately 3,500 acres located near Havana, in Mason County, Illinois. The reservoir, a floodplain lake adjacent to the Illinois River, is federal property managed by the U. S. Fish and Wildlife Service as a refuge for migratory waterfowl.

The biology of the Illinois River and its floodplain lakes was of considerable interest to early biologists working in Illinois (Bennett 1958:165-166). Some of their studies, and those reported by Thompson (1941:209-210), indicate that the floodplain lakes contained an abundance of fish foods and supported large standing crops of fish.

Drainage of Illinois River floodplain areas was begun before 1900. By 1929, about 200,000 acres of the floodplain had been drained and leveed off from the river for agricultural purposes (Mulvihill & Cornish 1929:36). Forbes & Richardson (1919:153) pointed out that the decline in the fishery of the Illinois River in 1908-1913 coincided with the increased drainage program of the period.

In 1947, the U. S. Fish and Wildlife Service recommended that the Corps of Engineers, U. S. Army, consider the possibility of acquiring five drainage and levee districts totaling 27,200 acres (formerly Illinois River floodplain lakes) for flood control reservoirs; the areas were to be used as public hunting and fishing grounds except in times of great floods (Jenkins & Walraven 1950:29). This recommendation stimulated a renewed interest in floodplain lakes

among conservationists in Illinois. As a result of this interest, representatives of the Illinois Natural History Survey, the Illinois Department of Conservation, and the U. S. Fish and Wildlife Service met in December, 1949, for the purpose of organizing a cooperative fishery research investigation at Lake Chautauqua. The objectives of the investigation, which was started in April, 1950 (Starrett & McNeil 1952:4), were "(1) to determine the values of the sport and commercial fisheries of an Illinois River bottomland lake; (2) to develop management practices that would increase the yield of sport and commercial fishes; (3) to study the biology of the fishes present; and (4) to estimate the dynamics of the fish population."

The economics of the fishery were discussed in an earlier paper (Starrett 1958). The calculated fishery value of the lake in 1954 was \$103,294.28, or \$29 per acre.

In 1950 and 1951, the Illinois Department of Conservation, through news releases and radio programs, informed anglers of the fishing possibilities at Lake Chautauqua. In 1952, a report was released on the sport fishery, based upon data from the previous 2 years of creel censusing (Starrett & McNeil 1952). This report stated that most anglers lacked knowledge on how to fish the lake and described successful methods of fishing, with the purpose of increasing the hook-and-line yield. Another effort to increase the hook-and-line yield was made in June, 1951, when a fishing "college" for anglers was conducted at the lake. Liberalized bass fishing regulations (continuous open

Frontispiece.—Aerial view showing part of Lake Chautauqua, a small section of the Illinois River, and a series of agricultural fields that were leveed off from the river in about 1920. Some of these fields were formerly covered by Thompson Lake, once a renowned fishing lake.

season and no size limits) were followed at Lake Chautauqua prior to their inclusion in the Illinois code. The liberalized regulations permitted anglers to remove more bass than was possible under the former restrictions "without measurably reducing the population of these fish" (Starrett 1955).

Crappies were taken in nets and seines by commercial fishermen and removed from the lake on an experimental basis in the period 1951-1954. This period was prior to enactment of the Illinois law that permitted the harvesting of crappies by commercial fishermen. Most of the crappies removed in the 1951-1954 period were taken in the 10 months beginning with September, 1951. The removal of crappies had no apparent effect upon the sport fishing (Starrett & Fritz 1957:14).

The yield of commercial fishes was greatly increased by permitting fishermen to use drag seines (beginning in 1951) and roundup fishing with wing nets (beginning in 1952). Formerly, fishermen had been allowed to set individual wing nets only.

In this paper, we are concerned largely with the various kinds of fishes and their relative abundance in Lake Chautauqua, their biology, the dynamics of their populations, and the effects of commercial fishing on them. We conducted some limnological investigations concurrently with the fishery research program. In 1950, engineers of the Illinois Water Survey made a sedimentation survey (Stall & Melsted 1951). Jackson (1954) collected a series of water samples for which dissolved oxygen determinations and water temperatures were recorded. Jackson & Starrett (1959) measured turbidities under various conditions. Paloumpis & Starrett (1960) made bottom fauna, chemical, and bacteriological studies.

We are indebted to a number of persons for their assistance during this investigation. The investigation was made possible through the efforts of Dr. George W. Bennett and Dr. Harlow B.

Mills of the Illinois Natural History Survey and Mr. Sam A. Parr of the Illinois Department of Conservation. Dr. Bennett gave guidance and encouragement during the investigation and later made helpful suggestions in the preparation of the manuscript. Messrs. Leslie L. Layton and Larry Bohm, supported under the D-J Project F-14-R for Illinois, gave aid in preparing the manuscript, and Dr. Donald F. Hansen of the Illinois Natural History Survey made many helpful suggestions and criticisms. Messrs. Louis Ellebrecht (now deceased), Lyle Schoonover, Robert Abney, C. Arthur Hughlett, and K. Duane Norman of the U. S. Fish and Wildlife Service extended us excellent cooperation while they were serving as refuge managers of the Chautauqua National Wildlife Refuge. Messrs. William Nuess, Walter Hart, Robert Crompton, John Schilling, and Howard Crum, present or former employees of the Illinois Natural History Survey, were helpful with field work. Mr. Frank C. Bellrose of the Illinois Natural History Survey was very helpful in giving advice and information on problems relating to waterfowl, aquatic plants, and the history of Lake Chautauqua. The following boat livery operators cooperated helpfully: Messrs. James Bridgeman (now deceased), John Lane, Paul Riddle, and Burt Sperry. All of the commercial fishermen who participated in our program were fully cooperative, and without their efforts the program would have failed. Messrs. P. L. McNeil and William Bain gave assistance while assigned to the senior author by the Illinois Department of Conservation. Dr. Milton B. Trautman of Ohio State University and Dr. Reeve M. Bailey of the University of Michigan identified several species of fish. Mr. James S. Ayars of the Illinois Natural History Survey edited the manuscript. Mr. William E. Clark and Mr. Wilmer D. Zehr, as Survey staff members, made the photographs; Mrs. Anne R. Dreyfuss, Miss Marguerite M. Verley, and Miss Artha

Sue Loy made the graphs; Mrs. Blanche P. Young read the proof and dummied the pages. Miss Loy drew the maps (Fig. 4 and 5) from original maps prepared by the junior author.

Financial support of this study was given by the Illinois Natural History Survey and the Illinois Department of Conservation.

MATERIALS AND METHODS

The fishery program on which this study is based included 10 growing seasons at Lake Chautauqua. The field work was started on April 15, 1950, and was concluded on October 10, 1959.

Collection of Data

During the 10 years of field work, various types of fishery data were collected by our staff. Some of the data were collected from commercial fishermen, some from the owners of boat livery, and some from the Illinois Department of Conservation. Most of the data were obtained through creel censusing by the staff or cooperators at boat livery, through wing-net fishing and seining by commercial fishermen, and through minnow seining and test-netting by the staff.

Commercial fishing on Lake Chautauqua was done by local fishermen who used wing nets, trotlines, and drag seines. These fishing devices have been described by Starrett & Barnickol (1955).

CREEL CENSUSING.—A creel census was conducted at all Lake Chautauqua boat livery in 1950–1954 (Starrett 1958:41–43) in the manner described by Starrett & McNeil (1952:5–6). Burt Sperry has continued to make creel censuses at his boat livery. Sperry's catch data are considered to represent about one-half of the total sport yield for the lake; this figure was determined by dividing the catch data recorded by Sperry for 1953 and 1954 by the catch data for the entire lake in these years.

TROTLINE FISHING BY SPORTSMEN.—Trotline fishing, limited to 50 hooks per

person, was permitted at Lake Chautauqua after 1953. A complete record of trotline fishing by sportsmen at the lake was kept in 1954 (Starrett 1958:42, 44). Thereafter, a record of the trotline catch by sportsmen was maintained by Sperry at his boat livery.

Sperry's records of trotline fishing and his creel census data were extrapolated each year after 1954 to give estimates of the annual yield of the total sport fishery at Lake Chautauqua.

COMMERCIAL WING-NET FISHING.—Commercial fishing with wing nets of legal mesh (1½-inch-square mesh or

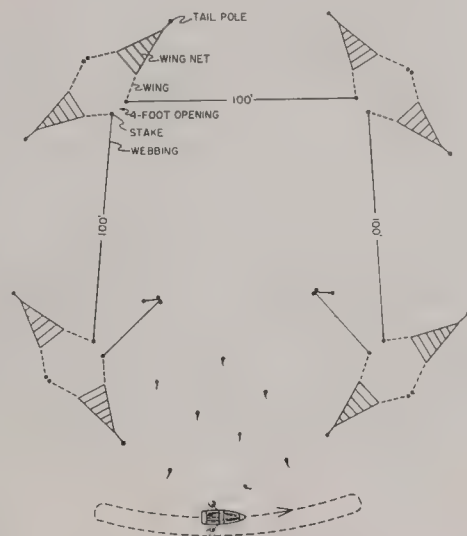


Fig. 1.—Diagram of a typical commercial roundup set with wing nets as used on Lake Chautauqua. The fishing crew consists of two men, who drive fish into the corral. When the fishermen believe sufficient numbers of fish are in the corral, they shut off the open end with lead netting and drive the fish into the wing nets set in the corners of the corral.

larger) was permitted on Lake Chautauqua in each year of field work from February or March through September. An effective method of commercial wing-net fishing (roundup) for big-mouth buffalo was developed and used by commercial fishermen in 1952 and afterward (Fig. 1 and 2). The commercial fishermen using wing nets were required by the U. S. Fish and Wildlife

Service to furnish monthly catch reports. In the years 1950-1959, 1,376,770 pounds of fish were removed from the lake by wing-net fishermen, or an average of 137,677 pounds per year. During the fishing months of 1951-1954, wing-net fishermen were required to deliver all crappies and white bass caught by

COMMERCIAL SEINING.—Each September, 1951-1958, a program of commercial seining was conducted in the lake. No seining had been allowed before 1951, and there has been no seining since 1958. The drag seines used in the program were operated by local commercial fishermen who had previously



Fig. 2.—Commercial wing nets set for roundup fishing. This method of fishing proved to be an efficient way to catch bigmouth buffalo during periods of low water at Lake Chautauqua.

them to a live crib located on the lake near the Natural History Survey Laboratory. Some of the white bass were tagged by our staff and returned to the lake. The other fish were given to the Illinois Department of Conservation for disposition.

COMMERCIAL TROTLINE FISHING.—Most of the commercial trotline fishing at Lake Chautauqua was done illegally. Estimated weights of channel catfish removed illegally and sold by trotline fishermen were obtained by us through contacts at local fish markets. The illegal removal of catfish by trotline fishermen in 1950-1959 was estimated to be 67,500 pounds.

signed a special seining contract with the Illinois Natural History Survey and the Illinois Department of Conservation. The fishermen were under bond to carry out the stipulations of the contract under the supervision of the senior author. The lengths of the seines ranged from 500 to 1,450 yards; the bags of these seines were of 11½-inch-square mesh and the remainder of 3-inch-square mesh or larger. During the 8 years of September seining, 348 hauls were made; the cumulative total was equivalent to 310,210 yards of seine. Fishermen furnished us with daily weight receipts covering the sales of their fish. Weights of gizzard shad and

garfishes removed and discarded were estimated by fishermen and the senior author. On most hauls, we made counts of the various species of sport fishes caught. In the 1951-1958 period, seiners removed 1,271,854 pounds of fish.

TEST-NET FISHING.—In late September and early October of each year, 1950-1959, test-netting with 1-inch-square-mesh wing nets with leads was done by our staff at 11 or 12 sites on the lake. The number of net-days of fishing in a fall varied from 47 to 94. During the 10-year period, 14,373 fish were caught in the 1-inch-square-mesh wing nets.

MINNOW SEINING.—In the years 1950-1959, 196 minnow seine hauls were made by our staff at various places on the lake. Most of the hauls were made with either a 20- or a 30-foot *Common Sense* minnow seine (one-eighth-inch mesh). In the minnow seine collections, 23,527 fish were taken.

USE OF ROTENONE.—Each summer, 1952-1959, one or two small areas (about one-eighth to one-fourth acre each) were treated by our staff with either powdered or emulsifiable rotenone. An attempt was made to collect with dip nets all of the fish that surfaced in the treated areas. The fish collected were identified, counted, and measured in the laboratory. In the rotenone operations, 1,484 fish were collected.

ELECTROFISHING.—A boom shocking device (230-volt a-c generator with three electrodes) was used by our staff to collect fish in 1959; 509 fish were collected with this shocker.

DEPARTMENT OF CONSERVATION FISHING.—Each year of the study, large numbers of sport fishes were removed from the lake by Department of Conservation personnel for the stocking of other lakes and ponds. These fish were caught in 1-inch-square-mesh wing nets. Records of the numbers of these fish were maintained.

TAGGING.—Several thousand fish, principally crappies and white bass, were caught in test-netting or commercial

fishing operations, tagged, and returned to Lake Chautauqua. Each of these fish was marked either on the opercular bone or dorsal spine (few white bass) with No. 3 monel strap tags. Tagging operations were confined to the fall and early spring months.

In September and October in the years 1950-1954, 4,295 crappies of 7 inches or longer, total length, were tagged and returned to the lake. Most of the marked crappies that were recaptured were caught by angling or by commercial wing-net fishing.

In the years 1951-1954, 605 white bass were caught in commercial seines and commercial wing nets, tagged, and returned to the lake. Most of the marked white bass that were recaptured were caught by angling and commercial wing-net fishing.

Classification of Fishes

In this study, we have followed the classification of fishes as used by Bailey (1956, 1960) or by Trautman (1957). Upon recommendation of Dr. Bailey (letter of November 4, 1964, to Dr. Philip W. Smith, Taxonomist, Illinois Natural History Survey), the spelling of the author name Lesueur (*LeSueur* formerly) is emended as it will appear in future editions of the list of fish names.

Most of the specimens collected were identified in the field. Representative specimens that could not be identified in the field were preserved for later determination by ourselves in the laboratory or were, in a few instances, submitted to Dr. Trautman or Dr. Bailey for identification. Specimens of the uncommon species of Lake Chautauqua fishes were deposited in the collections of the Illinois Natural History Survey, the Chicago Natural History Museum, or the Ohio State University Museum.

Measurements and Aging Materials

Length and weight data, and scales, spines, and opercular bones for aging fish, were obtained from fish collected at Lake Chautauqua by test-netting,

commercial seining, wing netting, angling, and electrofishing. We measured the total lengths, rather than the standard lengths, of fish to the nearest 0.1 inch; we determined weights to the nearest 0.01 pound on Chatillon scales. During the investigation, we weighed and measured 52,214 fish and, in addition, measured 12,814 small fish.

Of the fish collected, we aged 23,812. For species other than carp and catfish, we used only scales in making age determinations. For carp, we used scales, opercular bones, and dorsal spines. For catfish, we used pectoral spines. In aging fish by the scale method, we used a Bausch & Lomb microprojector for magnification of the scales. Most of the scales and spines were collected in September or October, and we considered a summer of growth prior to September 1 as a full year of growth. In the tables that show lengths of fish of various ages, an age 2 fish has one annulus, but it has completed two summers of growth. For example, a fish spawned in May, 1954, is classified as a 2-year-old fish in September, 1955. We made back calculations from the scales of several species to determine the first year's growth.

In 1953 and 1954, we collected opercular bones and scale samples from 466 carp. We were unable to separate the many checks and false annuli from the true annuli on these carp scales. In some instances, scales collected from carp that we thought were 1-year-old fish showed as many as four possible annuli. Other workers also have experienced difficulties in the use of scales for determining the ages of carp (McConnell 1952:138; English 1952:530-531). The method of aging carp from opercular bones, described by McConnell (1952:141, 143) and English (1952:536-538), we attempted with the Lake Chautauqua material. The first and second annuli appeared to be quite distinct on the opercular bones; however, on fish of 3 years and older we could not ascertain the annuli with any certainty.

To further explore the problem of aging carp, we decided in 1957 to look for annuli on the dorsal spines. With this objective, we removed 263 dorsal spines from carp taken in the September commercial seine hauls of 1957 and 1958.

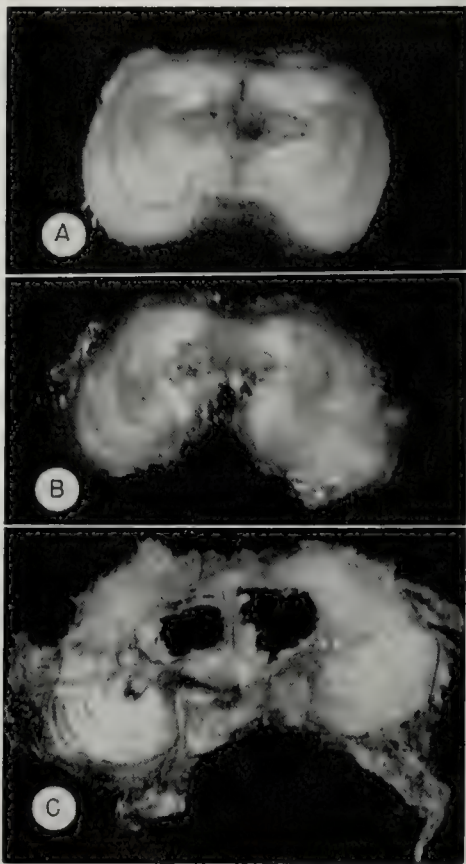


Fig. 3.—Magnified cross sections of carp spines collected at Lake Chautauqua. The cross sections show, A, two annuli, B, three annuli, and, C, six annuli.

After the spines were thoroughly dry, we cut four thin cross sections of each with a jeweler's saw. The first section in each instance included the base of the spine. We placed the sections from each spine in a petri dish containing water and examined them under a binocular dissecting microscope. The annuli appeared as translucent lines on the sections (Fig. 3). English (1952:536-538) found that sections of the dorsal

spine were satisfactory for determining the age and growth of carp up to 2 years old but difficult to interpret on older fish; he reported that the opercle was more satisfactory for aging carp of various ages. We believe that for aging Lake Chautauqua carp the dorsal spine was better than the opercular bone. In examining the 263 dorsal spines, we disagreed on the agings of 10 fish. Those fish were not included in our age data of carp.

We aged catfish by counting the annuli on cross sections of pectoral spines. Following a method similar to the one described by Sneed (1951:176-177) we cut the cross sections through the articulating portions of the spines with a jeweler's saw. We then placed the cross sections in a petri dish containing water, examined them under a dissecting microscope, and counted the annuli in the cross sections.

Calculations

For some of the abundant species of fish in Lake Chautauqua, we calculated the relationship between length and weight, the average index of condition, and the growth index.

LENGTH-WEIGHT RELATIONSHIPS.—To calculate weights (Lagler 1956:164-165) for various species of Lake Chautauqua fishes, we used the least squares method. In calculating weights for species in which only a limited number of data on lengths and weights were available, we combined the data for all years. For most of the abundant species, we calculated length-weight relationships from data collected each year in the months of September and October. The yellow bass, however, was an exception since the data for this species were collected in the spring months, rather than in September and October.

The length-weight relationship data for the various species have been deposited with the Illinois Natural History Survey Library, Urbana, Illinois, and with the Midwest Inter-Library Center, 5721 Cottage Grove Avenue,

Chicago 37, Illinois, and are available upon request from either library.

AVERAGE INDICES OF CONDITION, C.—Average fall indices of condition, C, were computed for eight abundant species in the lake. In computing C for the various species of fish, we used only length and weight data collected in September and early October, except that in 1954 we combined the November bluegill data with data for early fall.

First, we computed the index of condition (Thompson & Bennett 1939:17) for each one-half-inch length group of a given species by determining the value of C in the following formula

$$C = \frac{W \ 10,000}{L^3}$$

in which W is the mean weight and L the length for the group. Then we computed the C value for the species by calculating the average of the C values determined for the various one-half-inch length groups of the species.

The one-half-inch length groups for each species remained constant throughout the study. Ranges of total lengths used in calculating average C for the various species were as follows: freshwater drum, 10.5-16.5 inches; bigmouth buffalo, 16.0-25.5 inches; gizzard shad, 10.0-14.0 inches; carp, 16.5-24.5 inches; channel catfish, 14.5-19.5 inches; bluegill, 5.5-8.0 inches; black crappie, 7.0-10.5 inches; and white crappie, 7.5-10.5 inches.

GROWTH INDICES.—To show year-to-year changes in growth patterns of Lake Chautauqua fish, we calculated growth indices for each of six species. Each index figure was a measure of the deviation from an 8- or 10-year average of the total lengths for a given species. The growth indices provided measurements that could be used for comparing growth with population changes, fish removal, and varying water levels.

The method used for determining a growth index was based on a formula used by Purkett (1958:1-2):

$$\text{Factor} = \frac{1}{\text{Average length}} \times 100$$

Instead of using the average length for a year, as was done by Purkett, we used the sum of the average lengths for as many years as we had reliable data. In the following computation of the 1951 growth index for the drum, the data are from Table 1:

$$\text{Factor} = \frac{1}{38.8} \times 100 = 2.577$$

The factor is then applied to the appropriate figure in the column "Sum of

on formulas stated in the references given below. The analysis of variance (F) of the commercial seine haul data was done in accordance with formulas and procedures given by Simpson, Roe, & Lewontin (1960:272). Determinations of sample size relative to the number of seine hauls necessary to detect fluctuations in population were based on formulas presented by Paloumpis (1958:585). The t tests made in conjunction with the seine haul data were computed from formulas given by Starrett & Barnickol (1955:342-344). Correlation coefficients (r) used on the age

Table 1.—Growth indices of freshwater drum in Lake Chautauqua, 1951–1958, and data used in computing them. Lengths given are in inches and are total, rather than standard, lengths of fish.

Year	Average Length at Indicated Age in Given Year			Sum of Average Lengths for Given Year	Sum as Per Cent of 38.8 (Sum of Averages for All Ages and Years)	Growth Index
	3 Years	4 Years	5 Years			
1951	11.8	13.1	14.5	39.4	101.5	+1.5
1952	11.8	12.9	14.5	39.2	101.0	+1.0
1953	11.4	12.8	14.3	38.5	99.2	−0.8
1954	11.7	13.0	14.1	38.8	100.0	0.0
1955	11.2	12.4	13.8	37.4	96.4	−3.6
1956	11.6	12.7	13.7	38.0	97.9	−2.1
1957	11.8	13.2	14.4	39.4	101.5	+1.5
1958	11.9	12.7	13.9	38.5	99.2	−0.8
Average	11.7	12.9	14.2	38.8*		

*Sum of three averages to the left.

Average Lengths for Given Year," Table 1. For 1951, this figure is 39.4.

$$39.4 \times 2.577 = 101.5$$

The growth index for the drum in 1951 is 101.5–100.0 or +1.5, as shown in Table 1. This index indicates that the growth of the drum in 1951 was above the average for the species in the 1951–1958 period.

Our indices of growth were based on data from 12,432 fish.

STATISTICS.—The various statistical analyses used in this paper were based

and C factor data relative to water levels and population size were determined in accordance with the statistical methods of Snedecor (1946: 138–167).

RECORDS OF WATER LEVELS.—Of the water level records used in this paper, those for Lake Chautauqua were furnished by the U. S. Fish and Wildlife Service. Records of Illinois River stages at Havana were obtained from the daily Upper Mississippi River Stage and Forecast Bulletins issued by the U. S. Department of Commerce.

FISH REMOVAL

One of the ultimate objectives of this study was to increase the removal of fishes from Lake Chautauqua and to determine if the increased removal had any effects upon the fish populations. The methods of fish removal are described in this section of the paper. The effects of increased fish removal are discussed in a later section.

Fishing pressure on Lake Chautauqua prior to 1951 was comparatively light. Commercial fishing on the lake up to that year was restricted by government regulations to the use of individual wing nets. However, some local fishermen engaged in illegal trotline fishing.

The reported legal commercial removal of fish in the period 1942-1949 ranged from a low of 21,912 pounds in 1947 to a high of 123,106 pounds in 1948. (Statistics prior to 1950 were furnished by the late Lou Ellebrecht of the U. S. Fish and Wildlife Service.) These weights do not include several thousand pounds of fish that were removed each year by fishermen using trotlines illegally. Sport fishing pressure was comparatively light on the lake both before and during the study period. In the period 1942-1949, we believe, the total annual removal of fish

from the lake by all methods (legal and illegal) ranged from an estimated low of 12 pounds per acre to a high of 45 pounds per acre, with an average annual removal of 30 pounds per acre.

Removal by Commercial Wing-Net Fishing

In 1950 and 1951, the water levels at Lake Chautauqua were unusually favorable for commercial fishing with individual wing nets. The reported commercial wing-net catches at the lake in 1950 totaled 145,753 pounds and in 1951 they totaled 154,479 pounds, as shown in Table 2. These were the highest annual catches made with individual wing nets in the period 1942-1959; the annual wing-net catches given in Table 2 after 1951 included the roundup catches made with wing nets.

In 1952, two commercial fishermen began roundup fishing with wing nets and in August and September of that year caught 17,304 pounds of fish, of which buffalofishes accounted for 96.8 per cent (Table 3). In most years, very few fish were caught in the individual wing-net sets after the first of July.

Roundup fishing offered the commercial fishermen a method of catching fish with their wing nets during sum-

Table 2.—Estimated pounds of fish removed from Lake Chautauqua by various fishing devices and methods, 1950-1959.

Year	Pole-and-Line	Trotline		Commercial Wing Net	Commercial Seine	Conservation Department (Wing Nets)	Total
		Legal Angling	Illegal Commercial				
1950	17,717	...	8,000	145,753	.....	1,023	172,493
1951	22,180	196	8,000	154,479	84,685	1,537	271,077
1952	21,535	70	8,000	130,910	170,405	10,034	340,954
1953	9,414	50	8,000	156,403	86,426	163	260,456
1954	36,442	14,309	8,000	136,983	222,680	.....	418,414
1955	23,023	11,033	8,000	148,427	149,407	2,850	342,740
1956	15,510	7,194	8,000	115,158	140,401	2,300	288,563
1957	21,252	7,575	8,000	124,723	266,055	3,200	430,805
1958	14,362	7,492	2,000	108,274	151,795	3,889	287,812
1959	12,988	5,395	1,500	155,660	.....	2,274	177,817
Total	194,423	53,314	67,500	1,376,770	1,271,854	27,270	2,991,131

Table 3.—Catches made by commercial fishermen with individual wing nets and with wing nets used in the roundup method of fishing at Lake Chautauqua, 1952-1954.

Method of Fishing and Year	Carp		Buffalofishes		Freshwater Drum		Channel Catfish		Other Species		Total
	Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	
1952											
Individual wing nets	30,188	26.6	62,179	54.7	4,263	3.8	3,576	3.1	13,400	11.8	113,606
Roundup wing nets	532	3.1	16,746	96.8	8	°	18	0.1	0	..	17,304
1953											
Individual wing nets	4,666	12.6	29,389	79.1	815	2.2	139	0.4	2,136	5.7	37,145
Roundup wing nets	5,473	4.6	110,857	93.0	2,285	1.9	603	0.5	40	°	119,258
1954											
Individual wing nets	2,194	16.9	7,754	59.9	447	3.4	203	1.6	2,353	18.2	12,951
Roundup wing nets	7,286	5.9	113,552	91.5	2,480	2.0	697	0.6	17	°	124,032

° Less than 0.1 per cent.

mer months when water levels were usually low and catches in individual wing nets were poor. In the years 1952-1954, catches from roundup sets and individual wing nets were recorded separately. A summary of these separated catch data is presented in Table 3. In 1953 and 1954, the individual wing-net catches were quite poor compared with those made in the 3 previous years (Tables 2 and 3). The roundup method of fishing produced a relatively high catch during periods in which the catch usually was poor with individual wing nets. The catch data in Table 3 clearly indicate the selectivity of the roundup method for buffalofishes. The combined catch of both methods of wing-net fishing in the years 1950-1959 amounted to 1,376,770 pounds. Without the adoption of roundup fishing, the wing-net catch probably would have been less than one-half of this amount. We were unable to obtain accurate data on the catch per net day because of irregularity in the raising of nets by the fishermen.

Removal by Commercial Seining

Commercial seining was done each year in September, 1951-1958. The ef-

Table 4.—Number of completed commercial seine hauls, yards of seine used (cumulative yardage), and number of seine crews fishing in September at Lake Chautauqua, 1951-1958.

Year	Number of Hauls	Yards of Seine (Cumulative)	Number of Seine Crews
1951	13	14,200	3
1952	24	23,400	4
1953	47	34,500	4
1954	57	49,650	6
1955	66	56,250	6
1956	50	46,080	4
1957	43	42,680	5
1958	48	43,450	5
Total	348	310,210	11*

*Number of seine crews that fished during program.

fort expended in seining is shown in Table 4.

In most years, 1951-1958, the take of fish with seines was about equal to the catch by all other methods combined (Table 2). By fishing the lake with seines, fishermen removed fairly large poundages of gizzard shad, freshwater drum, and channel catfish that would not have been taken with wing nets. The yield from seining amounted to 42.5 per cent of the weight of fish removed by all methods and devices in the 1950-1959 period.

Removal by Angling

The estimated weight of fish removed by anglers or pole-and-line fishermen in the period 1950-1959 is presented in Table 2. After 1950, anglers' catches amounted to less than 10 per cent of the fish removed from the lake by other methods and devices of fishing. The sport fish removal by angling during the period of the study averaged only 5.5 pounds per acre per year. In 1954, a year of good fishing, the pole-and-line fishing pressure amounted to only 22 hours per acre. During the 1950-1959 period, we estimated, anglers removed 194,423 pounds of fish from the lake (Table 2). Most of these fish were white crappies, black crappies, bluegills, yellow bass, and freshwater drum.

Removal by Trotline Fishing

The illegal trotlines of commercial fishermen took mainly channel catfish. In most years of the investigation, we estimated, they took 8,000 pounds of catfish annually (Table 2). Fishermen and fish dealers noted that the commercial trotline catch dropped considerably in 1958 and 1959; they believed the drop was related to a decline in the catfish population.

The legal trotlines of anglers took principally channel catfish, freshwater drum, and bullheads. The estimated catch of these and other kinds of fish is shown in Table 2.

Table 5.—Estimated number of pounds of fish removed from Lake Chautauqua in each ing, commercial fishing (including crappies in experimental program), and fishing with wing

<i>Kind of Fish</i>	<i>1950</i>	<i>1951</i>	<i>1952</i>	<i>1953</i>	<i>1954</i>
Carp	52,495	80,442	52,566	25,438	60,314
Buffalofishes	68,114	136,833	186,816	165,361	186,800
Freshwater drum	22,027	13,781	34,904	34,626	73,197
Channel catfish	16,877	15,342	17,922	13,270	30,255
Gizzard shad	1,500	3,930	12,050	13,700	35,755
Crappies	4,047	12,936	27,666	6,013	19,859
Bluegill	2,034	2,990	3,077	635	6,041
Other fishes	5,399	4,823	5,953	1,413	6,193
<i>Total pounds</i>	<i>172,493</i>	<i>271,077</i>	<i>340,954</i>	<i>260,456</i>	<i>418,414</i>
<i>Pounds per acre</i>	<i>48.4</i>	<i>76.1</i>	<i>95.7</i>	<i>73.1</i>	<i>117.5</i>

Removal by Department of Conservation

The Department of Conservation used wing nets in Lake Chautauqua to obtain fish for stocking other waters. An estimate of the catch made with the Department's nets is given in Table 2. Crappies, bluegills, and yellow bass were the principal species taken.

Total Removal

As mentioned previously, in the period 1942-1949, the annual total yield of fish from Lake Chautauqua averaged about 30 pounds per acre. In 1950, the yield was 48.4 pounds per acre (Table 5). In the following year, when the lake was seined for the first time, the yield was increased to 76.1 pounds per acre (Table 5). In 1954, the yield jumped to 117.5 pounds per acre, largely as a result of the concerted efforts of the seiners and roundup fishermen. The highest yield was in 1957, 121.0 pounds per acre. During the 10-year period of investigation, the yield was 2,991,131 pounds, or 839.7 pounds per acre. Buffalofishes (most of them bigmouth buffalo) accounted for 49.1 per cent of this yield. The combined catch of carp and drum comprised 29.4 per cent of the total yield. After 1953, until 1959 (no seining after 1958), gizzard shad formed an increased part of the total yield, but, during the study period, shad made up only 7.9 per cent

of the total catch. Channel catfish accounted for 6.9 per cent of the catch. The combined catch of bluegills and crappies comprised 5.0 per cent of the total. The remaining 1.7 per cent of the catch consisted largely of bullheads, carpsuckers, white bass, largemouth bass, bowfin, and garfishes.

DESCRIPTION OF LAKE CHAUTAUQUA

Both the historical background and the present status of Lake Chautauqua are relevant to our study.

Historical Background of the Lake

The area now occupied by Lake Chautauqua was formerly a series of bottomland lakes connected with the Illinois River (Fig. 4 and 5). The water levels of these lakes fluctuated with the river. Largemouth bass fishing in these lakes was considered by the old timers as excellent. The Illinois Fisherman's Association (Cohen, Bartlett, & Lenke 1899:7) reported that in the year ending January 15, 1898, the commercial catch of "black bass" was 13,061 pounds at Havana. Most of this catch was believed to have been taken from the series of lakes now occupied by Lake Chautauqua and the Thompson Lake Drainage and Levee District (Fig. 4 and 5).

By 1925, nearly all of these lakes, including those in the area now oc-

year, 1950–1959. The figures include removal by sport fishing, legal and illegal trotline fish-nets operated by Illinois State Department of Conservation personnel.

1955	1956	1957	1958	1959	Total Pounds	Per Cent of Total Pounds of All Species
36,189	30,234	86,024	74,711	33,154	531,567	17.8
161,406	142,300	191,620	116,015	112,388	1,467,653	49.1
62,888	30,521	39,804	29,649	4,279	345,676	11.6
29,732	31,897	27,607	13,020	10,185	206,107	6.9
29,571	37,660	63,670	36,865	2,000	236,701	7.9
8,724	4,468	7,432	3,456	1,521	96,122	3.2
9,314	9,603	10,129	6,953	3,941	54,717	1.8
4,916	1,880	4,519	7,143	10,349	52,588	1.7
342,740	288,563	430,805	287,812	177,817	2,991,131	
96.2	81.0	121.0	80.8	49.9	839.7	

cupied by Lake Chautauqua (Fig. 5), had been drained and leveed off from the river for agricultural uses. In 1924, a fair crop of corn was produced in the Lake Chautauqua Drainage and Levee District. Flood waters of the Illinois River in the fall of 1926 broke the levees surrounding the Chautauqua District and flooded the area (Mulvihill & Cornish 1929:54). The district was not reclaimed for agricultural purposes. Fishes from the Illinois River became established in the newly formed lake. Various species of submerged aquatic plants attractive to waterfowl abounded in the reflooded area. In 1936, personnel of the U. S. Biological Survey (predecessor to the U. S. Fish and Wildlife Service) found the area suitable for use as a refuge for migratory waterfowl and initiated purchase of the drainage district. The federal agency repaired the levees and installed spillways and control gates. By 1940, the refuge manager was able to maintain a stable water level in the lake during moderate to low river stages; the stable water level was for the purpose of propagating duck food plants. Longleaf pondweed, *Potamogeton americanus*, and coontail, *Ceratophyllum demersum*, were the most abundant plants at Lake Chautauqua in 1938 and among the most abundant in 1939 and 1940 (Bellrose 1941:243).

In the spring and early summer months of 1943 and 1944, near-record floods occurred in the Illinois River valley. The flood waters were heavily laden with silt, and vast deposits of silt were made in the lake. The siltation that occurred during those two flood periods evidently produced drastic changes in the ecology of the lake. Prior to 1943, the lake bottom was fairly firm. The fine sediments deposited in the lake during the floods formed a soft, silty layer over the bottom. According to Frank C. Bellrose of the Illinois Natural History Survey (personal communication, 1952), most of the formerly abundant aquatic and marsh plants disappeared from the lake following the floods in 1943 and 1944 and failed to become re-established. The yellow perch population in the lake declined drastically following the disappearance of aquatic vegetation formerly available to this species for spawning (Starrett & McNeil 1952:21-22). According to local commercial fishermen, freshwater drum and channel catfish increased in abundance after 1944. Boat liverymen interviewed stated that largemouth bass fishing seriously declined in the lake after 1944.

Present Status of the Lake

Lake Chautauqua is a lateral-levee lake, similar to Type 58 described by

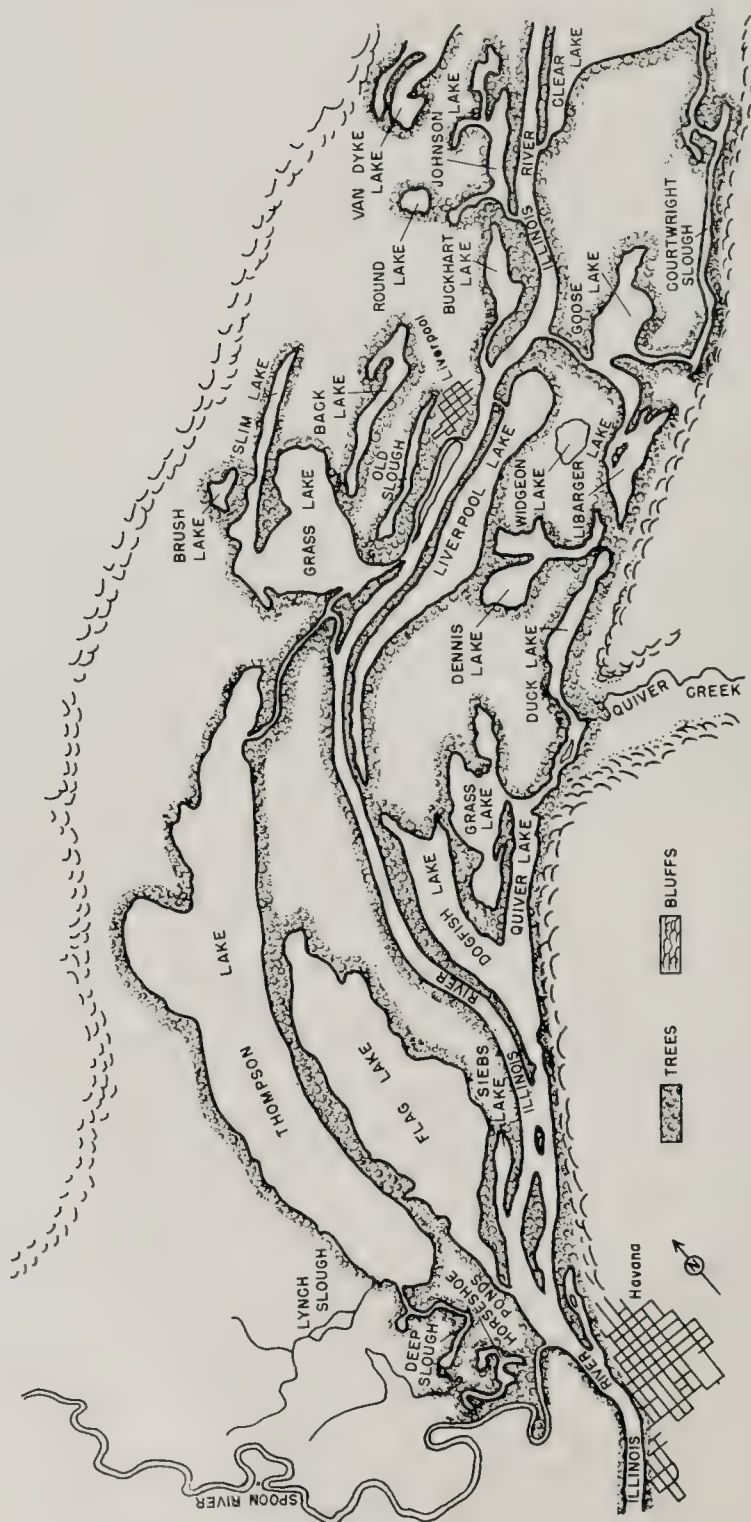


Fig. 4.—Map of the Illinois River and its adjoining bottomland lakes above Havana before 1912. The map was based on original plat maps filed in the court house at Lewistown, Illinois, and on an old sketch map, which was owned by Paul Riddle of Liverpool, Illinois. It was checked by William Riley and Frank Rudolph, commercial fishermen residing in Havana; both had fished in the various lakes shown on the map. Between 1916 and 1922, most of the lakes shown north of the river were drained. The area covered by this map is the same as that depicted in Fig. 5.

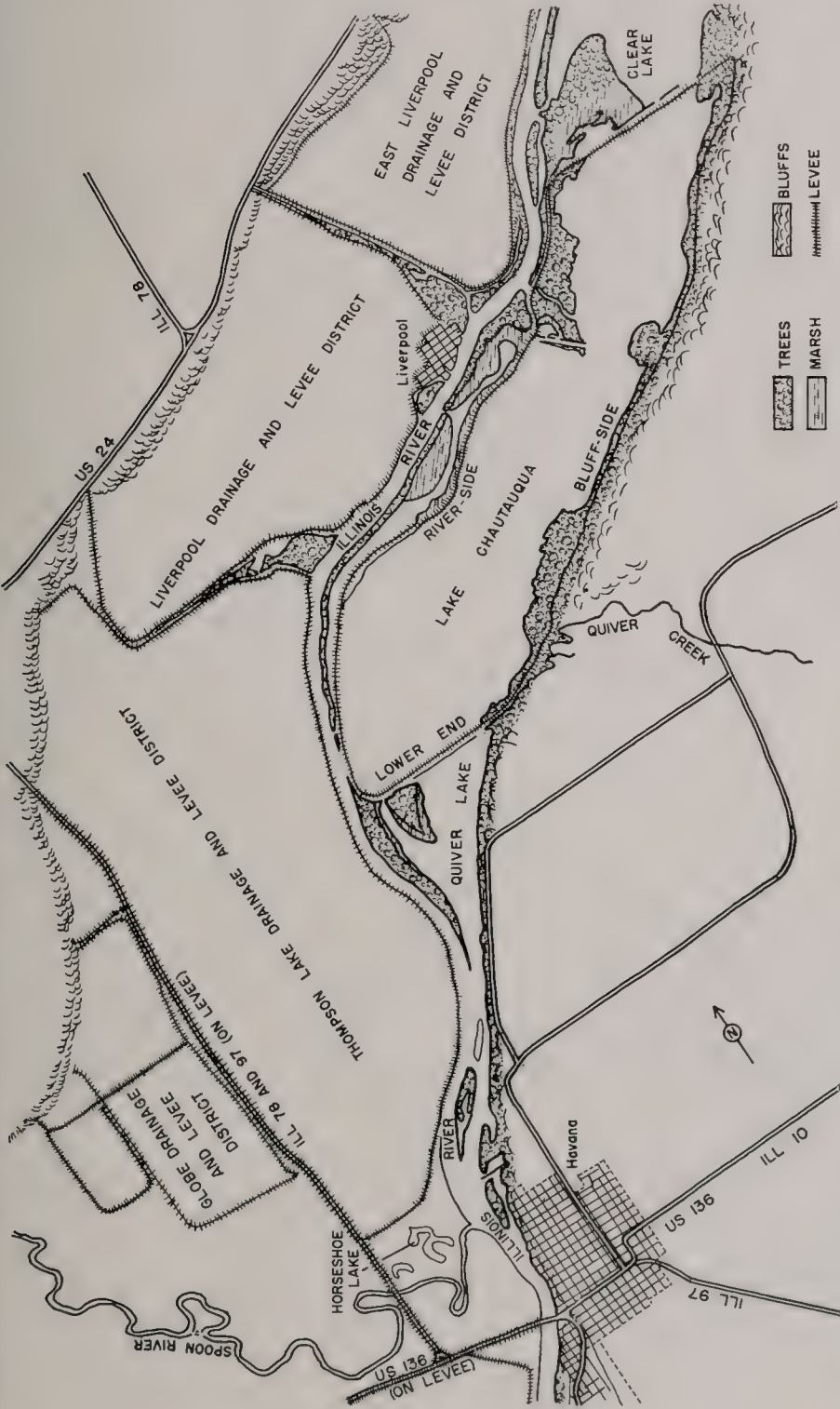


Fig. 5.—Map of the Illinois River and its adjoining bottomland lakes above Havana in 1960. This map shows that the lakes north of the river in Fig. 4 have been drained and leveed off from the river. After World War I, the area now occupied by Lake Chautauqua was drained and surrounded by levees. The Lake Chautauqua Drainage District was flooded in 1926 and was not reclaimed for agricultural uses.

Hutchinson (1957:123-125). The lake is over 6 miles long and varies in width from one-half mile to $1\frac{1}{2}$ miles. At normal pool elevation (435.0 feet above mean sea level), the surface area of the lake is 3,562 acres (Stall & Melsted 1951:10). The depth of Lake Chautauqua, which depends upon the magnitude and duration of high waters occurring in the Illinois River, varies considerably each year; at normal lake stage, most of the lake is 2 to 3 feet in depth.

WATER LEVELS.—During the period of our 10-year study, water levels at Lake Chautauqua were not affected by flood waters of the Illinois River until the latter reached heights of about 437.5 feet above mean sea level. At this stage, river water began to flow into the lake and increased the depth of the lake 2.5 feet or more, the depth depending upon the magnitude of the flood. Usually personnel of the U. S. Fish and Wildlife Service would open the control gates between the lake and the river before the 437.5-foot stage was reached. The fluctuations of the water levels at Lake Chautauqua and the Illinois River at Havana are discussed in another section of this paper.

VEGETATION.—Since 1944, sago pondweed, *Potamogeton pectinatus*, has been the only submergent aquatic plant to grow abundantly in Lake Chautauqua. Its abundance in the period 1950-1959 varied considerably from year to year. Sago pondweed was seen growing only during the warmest months of the year; it flourished only in years when the water levels were stable during the growing season.

During the period 1950-1959, there were only two growing seasons (1953 and 1956) in which the Illinois River did not overflow into the lake. In those two years, the growth of sago pondweed was heavy, whereas, in other years (except 1959), the growth of pondweed varied from none to moderate, the extent of growth depending upon the time high water levels oc-

curred and the duration of their occurrence. In 1959, water levels reached 437.5 feet on only one day, in early June; after that date, the lake level was dropped by the U. S. Fish and Wildlife Service personnel to a level of 6 inches lower than in any previous summer during the study. The shallow, stable water levels in 1959 resulted in the heaviest stand of sago pondweed observed in the lake.

SEDIMENTATION AND TURBIDITY.—The sedimentation survey of the lake made in 1950 revealed that silt or sediments deposited in Lake Chautauqua during flood periods on the Illinois River in 23.8 years had reduced the lake's storage capacity by 18.3 per cent (Stall & Melsted 1951:1). Jackson & Starrett (1959:160) stated that

The sediments in Lake Chautauqua are mostly of a fine texture and form a loose, flocculent "false bottom" (not similar to the type found in bog lakes) over the original lake bottom. A slight disturbance of the "false bottom" causes particles to become resuspended and so increases the turbidity of the water. According to Stall and Melsted [1951], the largest sediment particles of Lake Chautauqua begin to settle after the disturbance ceases; however, it takes from 7 to 12 days for much of the sediment in the lake to settle to the bottom.

Observed turbidity in the years 1953-1957 "ranged from less than 25 to 800 p.p.m." (or units).

In the absence of sago pondweed, the turbidity of the lake, caused by resuspension of sediment particles, was affected by wave action and water depth. The relatively low turbidity resulting from the presence of vegetation in years of low stable water levels might be expected to favor sight-feeding fish. In years of low and stable water levels, additional food was available in the form of the vegetation itself and of immature insects, which tended to flourish on the sago pondweed.

WATER AND SOIL CHEMISTRY.—A summary of chemical analyses of water samples taken at Lake Chautauqua in 1953 and 1954 by Paloumpis & Starrett (1960:407) showed the following mean

chemical determinations in parts per million or units: pH (8.2), PO_4 (0.4), SiO_2 (5.7), SO_4 (63.8), NO_3 (1.1), NH_4 (0.3), Na (8.5), alkalinity as CaCO_3 (141.7), and hardness as CaCO_3 (209.8).

We believe that waterfowl as well as flood waters of the Illinois River have increased the fertility of Lake Chautauqua. Paloumpis & Starrett (1960:427) estimated that in the fall, winter, and spring of 1954-55, waterfowl deposited organic material in the lake on a per-acre basis as follows: 12.8 pounds of nitrogen, 17.1 pounds of total phosphate, and 8.1 pounds of soluble phosphate. Stall & Melsted (1951:12) reported the chemical and physical characteristics of four sediment samples collected at Lake Chautauqua. These authors stated that

The total carbon and total nitrogen values are extremely high, indicating an accumulation of organic matter in the lake far in excess of any amounts that could be accounted for through soil erosion. These large accumulations of nitrogen and carbon must, therefore, be attributed to wildlife excreta.

Jackson (1954:82) did not detect any thermal stratification in Lake Chautauqua. He attributed the lack of stratification to the shallowness of the lake.

During our 10-year investigation at Lake Chautauqua, the senior author observed only two summer fish kills, one of which is described by Jackson & Starrett (1959:164). Both of these kills were localized, and they occurred during periods of prolonged hot weather and in the presence of heavy blooms of blue-green algae.

BOTTOM FAUNA.—Bottom fauna studies conducted on Lake Chautauqua in 1952-1956 by Paloumpis & Starrett (1960:420) showed that the lake supported a large dipterous larva population composed principally of the genera *Pelopia*, *Procladius*, *Coelotanypus*, and *Tendipes*. The maximum annual production of dipterous larvae, in terms of weight, was estimated to be approximately 2,400 pounds per acre.

SPORT FISHERY.—In 1950-1954, the annual pole-and-line catch per fisherman at Lake Chautauqua varied from 0.6 to 0.8 fish per hour (Starrett 1958:43). Most of the fish caught by anglers were crappies, bluegills, yellow bass, and freshwater drum. In this period, the number of anglers fishing the lake annually varied from 5,675 to 13,717. Their total annual catches in that period ranged from 9,414 to 36,442 pounds



Fig. 6.—Anglers fishing for crappies at a man-made brush pile in Lake Chautauqua. In 1950-1954, the annual number of anglers at the lake ranged from 5,675 to 13,717.

of fish. Most of the fish were caught by still fishing (Fig. 6) in which live bait was used.

Freshwater drum, bullheads, and channel catfish comprised most of the trotline catch by sport fishermen in 1954 (Starrett 1958:44).

COMMERCIAL FISHERY.—The reported annual catch of fish taken legally by commercial fishermen at Lake Chautauqua in 1950–1959 ranged from 144,254 to 326,808 pounds. Bigmouth buffalo, carp, freshwater drum, and channel catfish were the principal species taken by the commercial fishermen. These figures do not include some of the fish included in Table 2.

KINDS OF FISHES IN THE LAKE

During periods of high water levels in the Illinois River, Lake Chautauqua is contiguous with the river and at such times the various species of fish in the river have easy access to the lake. Since 1926, the year the property of the Lake Chautauqua Drainage and Levee District was flooded, perhaps 90 or more species of fish have had an opportunity to invade Lake Chautauqua from the river. In the present study, we identified 64 species of fish taken from Lake Chautauqua. At least 30 of these species were either rare or rare-occasional in their occurrence. Most of these rare or rare-occasional species collected were probably transient individuals that had moved into the lake during high water and had failed to move out when the river water receded. Twenty-one additional species ranged in abundance from occasional to common in the lake. Of the 64 species recorded for the lake, only 13 occurred abundantly or very abundantly in 1 or more years. They are the following:

- Bigmouth buffalo (very abundant)
- Gizzard shad (very abundant)
- Carp (very abundant)
- Freshwater drum (very abundant)
- Bluegill (very abundant)
- White crappie (very abundant)
- Black crappie (very abundant)

Yellow bass (common to very abundant)

Channel catfish (abundant)

Shortnose gar (fairly abundant)

Emerald shiner (scarce to abundant)

Spottail shiner (scarce to abundant)

Brook silverside (scarce to abundant)

Several biologists studied the fishes of Lake Chautauqua prior to the present investigation. Schloemer (1939:60) included a series of bluegills collected from Lake Chautauqua in his age and growth study of that species. Hansen (1942:198), who conducted a partial creel census on the lake in 1941 and 1942, reported that anglers caught the following kinds of fish: the largemouth bass, smallmouth bass, bluegill, crappie (kind or kinds not specified), other sunfish, yellow perch, yellow bass, sheepshead, bullhead, channel catfish, buffalo, dogfish, eel, carp, and others. Hansen (1943:175) also reported a large die-off of the yellow bass and smaller die-offs of the white crappie, black crappie, sheepshead, gizzard shad, and bluegill at Lake Chautauqua. In a later paper, Hansen (1951:234, 256) mentioned the occurrence of lymphocystis on the white crappie in Lake Chautauqua and recorded total length of two age-classes of this species in the lake. In a paper on sport fishing at Lake Chautauqua, Starrett & McNeil (1952:8) listed the species commonly caught by anglers at the lake. Larimore (1957:65), in his paper on the ecology of the warmouth in Illinois, included age and growth data on 30 individuals of that species taken from Lake Chautauqua. All of the species reported above by other workers were taken in the present investigation except the smallmouth bass.

In this section, we include all of the species taken by us in the period 1950–1961 and indicate the relative abundance of each species as determined from our collections.

Family Petromyzontidae

This family was represented by one species in the Lake Chautauqua collections. Starrett, Harth, & Smith (1960: 345), who studied the parasitic lampreys of Illinois rivers, considered lampreys scarce in the Illinois River above Florence, which is several miles below the La Grange navigation dam near Beardstown.

CHESTNUT LAMPREY, *Ichthyomyzon castaneus* Girard: Rare.—Beginning in 1949, commercial fishermen were requested by the senior author to save all lampreys taken from Lake Chautauqua. In the period 1949–1960, only two specimens were collected. Both were identified as the chestnut lamprey. One specimen (7.4 inches total length) was collected from a carp on May 12, 1959. The other specimen (6.3 inches) was found on April 11, 1960, in the bottom of a fisherman's boat shortly after he had raised his nets. No lamprey-scarred fish was noted by us in the commercial catches.

Family Polyodontidae

The paddlefish is the only representative of this family in North America.

PADDLEFISH, *Polyodon spathula* (Walbaum): Occasional.—During the investigation, only 214 pounds of paddlefish were removed from Lake Chautauqua by commercial fishermen. This species, which has some local commercial value, is sold under the name "spoonbill cat." The largest paddlefish taken from the lake weighed 29 pounds. Another specimen measured 47.5 inches in length and weighed 21 pounds. Paddlefish were taken in Lake Chautauqua only during years of sustained high water levels, such as occurred in 1950 and 1951. We are of the opinion that the specimens taken in Lake Chautauqua had moved up the Illinois River during high river stages. At a high river stage, the wickets of the La Grange navigation dam near Beardstown are lowered, thereby allowing fish to pass through without obstruction from the Missis-

sippi River up the Illinois River to Havana. The paddlefish is not known to spawn in the Illinois River system. Forbes & Richardson (1920:17) in about 1908 considered the paddlefish as "rather rare" in the Illinois River above Meredosia.

Family Lepisosteidae

At the time of our study, the garfishes were of no commercial value in the Havana area. The shortnose gar was fairly abundant, and the longnose gar was taken occasionally. Gars taken by commercial fishermen were usually killed and discarded. Anglers using minnows for bait frequently hooked garfish. Only a very few anglers considered the gar as a desirable food fish.

We believe that garfishes spawned in Lake Chautauqua; however, only three young of this family (shortnose gars of 1.0 to 4.0 inches) were taken in minnow seine collections. In 1958, approximately 5 pounds of garfishes were caught per 100 yards of commercial seine.

The spotted gar, *Lepisosteus oculatus* (Winchell), which closely resembles the shortnose gar, was not found at Lake Chautauqua, Lake Matanzas, Quiver Lake, or in our Illinois River collections above Havana. The only spotted gars collected in the immediate area were three specimens taken on February 12, 1960, in a commercial seine haul at Ben's Lake, a small overflow lake adjacent to the Sangamon River, in Mason County. The specimens ranged from 13.6 to 13.9 inches in length. The silted waters and lack of permanent vegetation in Lake Chautauqua evidently provided a more favorable habitat for shortnose gar than for spotted and longnose gars.

SHORTNOSE GAR, *Lepisosteus platostomus* Rafinesque: Fairly abundant.—The heaviest shortnose gar measured 28.3 inches long and weighed 3.29 pounds. The average weight of shortnose gars in the test-net collections was 1.57 pounds.

LONGNOSE GAR, *Lepisosteus osseus* (Linnaeus): Occasional.—This species was much less abundant in Lake Chautauqua than the shortnose gar. The largest longnose gar measured 47.1 inches total length and weighed 12 pounds.

Family Amiidae

The only Lake Chautauqua representative of the bowfin family is of minor importance as a commercial species in Illinois. It is sometimes sold as "catfish" to unsuspecting customers. Most people do not care for the bowfin as food because of its "mushy" flesh.

BOWFIN, *Amia calva* Linnaeus: Common.—At the time of our study, the bowfin was not abundant enough in Lake Chautauqua to have much effect on the fishery as a predator. Anglers occasionally caught bowfins while fishing with minnows for bass or crappies. The commercial catch of bowfins at Lake Chautauqua in 1950–1959 amounted to 3,271 pounds. The largest bowfin caught in a 1-inch-mesh wing net measured 27.1 inches long and weighed 7.45 pounds. No young bowfin was collected during the study, but we believe that the species probably spawned in the lake.

Family Clupeidae

The skipjack herring and the gizzard shad were the only members of the herring family taken at Lake Chautauqua.

SKIPJACK HERRING, *Alosa chrysochloris* (Rafinesque): Rare.—On October 2, 1951, two adult specimens of this species were collected while we were test-netting at Lake Chautauqua (17.6 inches, 1.89 pounds; and 15.6 inches, 1.30 pounds). The specimens probably entered the lake from the Illinois River during a period of high water.

GIZZARD SHAD, *Dorosoma cepedianum* (Lesueur): Very abundant.—This species was one of the most abundant fishes in Lake Chautauqua during the period of our study. It was of no

direct value to the sport or commercial fisheries of the lake; however, it was thought to be of great importance as a forage fish for the crappies, large-mouth bass, white bass, garfishes, channel catfish, freshwater drum, and possibly the yellow bass and the bowfin. The largest shad collected was 16.5 inches long and weighed 1.57 pounds.

Family Hiodontidae

A few adults of the mooneye family were taken at Lake Chautauqua. In all probability, these fish had entered the lake from the river during periods of high water. Anglers occasionally hooked a goldeye or a mooneye. These fish were too scarce in the lake to have been of any importance to the fishery.

GOLDEYE, *Hiodon alosoides* (Rafinesque): Occasional.—The goldeye appeared to be less abundant in the lake than the mooneye. The largest goldeye taken was 12.0 inches long and weighed 0.61 pound.

MOONEYE, *Hiodon tergisus* Lesueur: Occasional.—The largest mooneye taken in the test-net collections was 10.6 inches long and weighed 0.39 pound.

Family Esocidae

The grass pickerel and the northern pike were the only members of the pike family taken in Lake Chautauqua.

GRASS PICKEREL, *Esox americanus vermiculatus* Lesueur: Rare to occasional.—A single specimen of this species was taken at Lake Chautauqua in 1950. None was collected after 1950 until 1959. In 1959, six adult specimens were caught in nets, and one was caught by an angler. During high water, the grass pickerel probably moves into the lake from adjoining Quiver Creek, where the species is quite common. The largest grass pickerel taken in Lake Chautauqua was 13.3 inches long.

NORTHERN PIKE, *Esox lucius* Linnaeus: Rare.—We have the record of a single specimen from Lake Chautauqua. On April 3, 1961, a female pike, 24.1 inches in total length and 4.02

pounds in weight, was taken in a commercial wing net set in the lake by Sam Kelly. The northern pike is now rather rare in the Havana area, and the specimens taken had probably entered the lake during high water. We have only one recent record of a pike that was caught in waters near Lake Chautauqua. On February 26, 1958, Edward W. Kelly brought us a northern pike (23.2 inches in total length and 2.61 pounds in weight), which he had just captured in a commercial wing net set in Quiver Lake. Quiver Lake lies adjacent to Lake Chautauqua, and the two lakes connect with one another during high water.

Family Cyprinidae

This large family, the minnows and carps, was represented by 15 species in Lake Chautauqua. Carp, emerald shiner, and spottail shiner were the only species of this family that we found occurring abundantly in the lake.

CARP, *Cyprinus carpio* Linnaeus: Very abundant.—This was one of the most abundant fishes occurring in Lake Chautauqua in the years of our study. Few carp were caught by anglers, but the species was of some importance to commercial fishermen. In the period 1950–1959, commercial fishermen removed from the lake 522,704 pounds of carp valued at \$22,540. The average weight of carp taken in the commercial seine hauls at Lake Chautauqua was 4.82 pounds. The largest carp handled was 36.4 inches long and it weighed 28 pounds. Only one carp observed from the lake exhibited the knothead condition usually associated with polluted water (Thompson 1928:317). This individual probably originated from upstream in the Illinois River, where pollution was more severe than in the Havana area and where the knothead condition of carp was quite common.

GOLDFISH, *Carassius auratus* (Linnaeus): Rare.—An orange-colored goldfish was taken in a commercial seine haul at Lake Chautauqua in 1957. The specimen was 10.0 inches long and

weighed 0.78 pound. Goldfish were very abundant in the polluted waters of the Des Plaines River, part of the Illinois River system, and in the upper part of the Illinois River above the Starved Rock navigation dam. We have caught as many as 103 adult goldfish per net-day in our sets made in the Des Plaines River. Most of the specimens collected by us in the Illinois River and the Des Plaines River were brownish or bronze in color. Goldfish were taken only occasionally in the Illinois River below Pekin. One goldfish-carp hybrid was caught at Lake Chautauqua in a commercial seine haul in 1956. The fish weighed 5.44 pounds and was 20.4 inches in length. Both the goldfish and the goldfish-carp hybrid probably came into the lake from the river.

CREEK CHUB, *Semotilus atromaculatus* (Mitchill): Rare.—Two immature creek chubs were collected from Lake Chautauqua in 1958. These fish probably came into the lake from the river during a period of high water.

GOLDEN SHINER, *Notemigonus crysoleucas* (Mitchill): Common.—This species varied in abundance from year to year during our 10-year investigation. Most of the specimens taken at the lake were less than 3 inches in length. One specimen 7.5 inches long was taken in a 1-inch-mesh wing net. The golden shiner was not sufficiently abundant in Lake Chautauqua to be of much importance as a forage fish. The occurrence of the golden shiner in minnow seine collections was 2.3 fish per haul. This species spawned in the lake.

SUCKERMOUTH MINNOW, *Phenacobius mirabilis* (Girard): Rare.—Only four specimens of this minnow were collected from Lake Chautauqua. These fish had probably moved into the lake from the river during high water levels.

EMERALD SHINER, *Notropis atherinoides* Rafinesque: Scarce to abundant.—This species and the spottail shiner were the only abundant minnows other than carp collected from Lake Chau-

tauqua. No specimen of the emerald shiner was collected in the lake in 1954 and 1956; in 1957, this species was very abundant and averaged 49.2 fish per minnow seine haul. The emerald shiner averaged 14.4 fish per haul in the minnow seine collections of 1950-1959. This shiner spawned in Lake Chautauqua.

SPOTTAIL SHINER, *Notropis hudsonius* (Clinton): Scarce to abundant.—In the minnow seine collections of 1950-1959, this species averaged 15.7 fish per haul. Our data for the 10-year study showed the spottail shiner slightly more abundant in the lake than the emerald shiner. The spottail shiner spawned in Lake Chautauqua. The emerald shiner and the spottail shiner were both considered important forage fishes.

BIGMOUTH SHINER, *Notropis dorsalis* (Agassiz): Rare to occasional.—This typical stream fish was taken in 10 different minnow seine hauls at the lake. The specimens collected probably entered the lake during high water. The average occurrence of this species in all the minnow seine collections was 0.2 fish per haul.

RED SHINER, *Notropis lutrensis* (Baird & Girard): Rare to occasional.—The occurrence of this species in the minnow seine collections at Lake Chautauqua was 0.1 fish per haul. The red shiners collected probably entered the lake during high water levels.

SAND SHINER, *Notropis stramineus* (Cope): Rare to occasional.—Prior to 1958, only one specimen of the species had been reported taken in Lake Chautauqua. In 1959, 94 sand shiners were taken with the minnow seine over sand bottom. This species may have had some success in spawning and establishing itself in the lake. Its occurrence in the minnow seine collections was 0.6 fish per haul.

SILVERY MINNOW, *Hybognathus nuchalis* Agassiz: Rare to occasional.—This species was taken at Lake Chautauqua only in 1959. However, in that year, it was caught in six different min-

now seine hauls. We have taken the silvery minnow quite regularly in our Illinois River collections in the vicinity of Havana. The specimens collected at Lake Chautauqua probably came into the lake from the river. Occurrence of the silvery minnow in the minnow seine collections at Lake Chautauqua in 1950-1959 averaged 0.1 fish per haul.

BULLHEAD MINNOW, *Pimephales vigilax* (Baird & Girard): Occasional.—A few specimens of the bullhead minnow were collected from the lake in most years of our 10-year study. The occurrence of this species in the minnow seine collections averaged 0.1 per haul.

BLUNTNOST MINNOW, *Pimephales notatus* (Rafinesque): Rare to occasional.—The bluntnose minnow was collected at the lake in three different years. Altogether, 36 fish of this species were taken, none of them adults. The occurrence of the bluntnose minnow in the minnow seine collections averaged 0.2 fish per haul.

FATHEAD MINNOW, *Pimephales promelas* Rafinesque: Rare.—Only eight specimens of this species were collected from Lake Chautauqua for our study.

STONEROLLER, *Camptostoma anomalum* (Rafinesque): Rare.—During our investigation, only seven specimens of this species were collected from Lake Chautauqua. This typical stream species probably entered the lake during high water. Its occurrence in the 196 minnow seine collections, 1950-1959, averaged less than 0.1 fish per haul.

Family Catostomidae

Members of the sucker family, other than the bigmouth buffalo, were not abundant in Lake Chautauqua in the period 1950-1959. Nine species of this family were collected.

BIGMOUTH BUFFALO, *Ictiobus cyprinellus* (Valenciennes): Very abundant.—In terms of standing crop (pounds of fish per acre), the bigmouth buffalo was the most abundant fish in Lake Chautauqua. Evidently the shallow and often turbid water of the lake furnished a

good habitat for the bigmouth buffalo. This species probably spawned each year; however, only in 1953 during our 10-year study was a large brood produced. During the study, only a few buffalo were caught by anglers.

The bigmouth buffalo was the most important commercial fish in the lake. In the period 1950-1959, commercial fishermen caught 1,467,389 pounds of buffalo, of which nearly all were the bigmouth. The value of the catch to the fishermen during that period was \$156,045. The average weight of the bigmouth buffalo in commercial seine hauls was 6.21 pounds (1951-1958); the largest bigmouth buffalo measured 32.5 inches long and weighed 26.5 pounds.

SMALLMOUTH BUFFALO, *Ictiobus bubalus* (Rafinesque): Occasional.—The smallmouth buffalo probably moves into Lake Chautauqua from the Illinois River, where it is sometimes taken by commercial fishermen. The largest specimen handled weighed 18.5 pounds.

BLACK BUFFALO, *Ictiobus niger* (Rafinesque): Occasional.—This species, like the smallmouth buffalo, was not abundant enough in Lake Chautauqua to be of any commercial importance. Most of the black buffalo were readily distinguishable from the smallmouth buffalo; a few fish appeared to be intergrades between the black buffalo and the smallmouth buffalo. The largest black buffalo handled was 28.9 inches long and weighed 16 pounds.

QUILLBACK, *Carpiodes cyprinus* (Lesueur): Occasional to common.—We experienced difficulty in accurately separating *Carpiodes cyprinus* from *forbesi* collected from the Illinois River and Lake Chautauqua. A series of adult specimens from the river and Lake Chautauqua was submitted to Dr. Milton B. Trautman of the Ohio State Museum. Dr. Trautman informed us (personal communication, June 23, 1960) that: "At present, I believe that this is a hybrid population. You have typical *forbesi*, typical *cyprinus*, and a nice series of intergrades in between." Later, Bai-

ley & Allum (1962:81) stated that they regarded *forbesi* not as a separate species but as a modification of *cyprinus*. We are in agreement with this conclusion and therefore name all of our specimens of the *forbesi-cyprinus* pair as *cyprinus*. The largest quillback identified by us was 17.5 inches long and weighed 2.62 pounds.

RIVER CARPSUCKER, *Carpiodes carpio* (Rafinesque): Common.—The adult and subadult river carpsuckers were easily distinguished in the field from other species of *Carpiodes* occurring in Lake Chautauqua. The river carpsucker occurred more abundantly in Lake Chautauqua than did the other species of carpsucker. Carpsuckers were not taken by anglers. A few pounds of carpsuckers, largely of this species, were caught each year commercially and sold as silver carp or carp. The largest river carpsucker handled was 19.3 inches long and weighed 4.4 pounds.

NORTHERN REDHORSE, *Moxostoma macrolepidotum* (Lesueur): Rare to occasional.—In the years 1950-1953, 13 adult specimens of the northern redhorse were taken in the test-net collections at Lake Chautauqua; no adult was taken after 1953. A few young-of-the-year fish identified as *Moxostoma* sp. were caught with a minnow seine in later years; these may have included young northern redhorses. The northern redhorses taken in the test-net collections ranged in length from 10.9 to 17.2 inches. The heaviest weighed 2.55 pounds.

WHITE SUCKER, *Catostomus commersoni* (Lacépède): Rare.—A single specimen of the white sucker was collected at Lake Chautauqua in 1951. The fish was 12.9 inches long and weighed 0.92 pound. In 2 months of continuous wing-net fishing at Lake Chautauqua in 1940, Donald F. Hansen of the Illinois Natural History Survey (personal communication, January 13, 1963) caught 16 white suckers. Evidently the species was more abundant in 1940 than in the period of our study.

SPOTTED SUCKER, *Minytrema melanops* (Rafinesque): Rare.—One specimen of this species was taken in a 1-inch-mesh wing net at Lake Chautauqua in 1952. It was 8.1 inches long and weighed 0.28 pound.

WESTERN LAKE CHUBSUCKER, *Erimyzon sucetta kennerlyi* (Girard): Rare.—Five adult chubsuckers were taken at Lake Chautauqua in 1958 and 1959. In 1958, James La Buy of the Illinois Department of Conservation (personal communication in September, 1958) found a rather large population of this species in Rice Lake, an Illinois River bottomland lake 6 river miles upstream from Lake Chautauqua. Permanent types of submergent vegetation flourished in Rice Lake at the time La Buy made his investigation. Donald F. Hansen of the Illinois Natural History Survey (personal communication of January 13, 1963) considered chubsuckers scarce in the lake in 1940. In 2 months of netting, he caught only three chubsuckers.

Family Ictaluridae

Seven species of catfishes were recorded from Lake Chautauqua during our investigation. The channel catfish was the only one of these species that occurred quite abundantly. The lack of permanent stands of submergent vegetation and the abundance of predatory fishes in the lake probably had an adverse effect upon the bullheads. The blue catfish and the flathead catfish were the only species of catfish taken that did not spawn in the lake.

BLUE CATFISH, *Ictalurus furcatus* (Lesueur): Rare.—Only two specimens of this species were taken at Lake Chautauqua during our investigation (17.6 inches, 2.00 pounds; 19.4 inches, 2.92 pounds). Both fish were aged as 4-year-olds. These specimens were taken in commercial seines in 1958. Blue catfish are occasionally taken in the Illinois River at Havana by commercial fishermen during periods of high water. Specimens of blue catfish examined by

us at a commercial fish market in Havana were about the sizes of fish taken at Lake Chautauqua. Local commercial fishermen informed us that they have never caught large blue catfish in the Havana area. Evidently only the blue catfish of small sizes move up the Illinois River from the Mississippi River during high water. Forbes & Richardson (1920:179) in about 1908 considered the blue catfish to be rare in the Illinois River.

CHANNEL CATFISH, *Ictalurus punctatus* (Rafinesque): Abundant.—During the period of our study, this species was important both as a sport and a commercial fish at Lake Chautauqua (Starrett 1958:43, 46). Seines and trotlines were the two most effective devices used for taking catfish. Channel catfish were a premium fish for the commercial fishermen since the wholesale undressed price during the 1950's remained consistently at about \$0.25 per pound. The other abundant commercial fishes fluctuated in price and were usually sold for less than \$0.10 per pound. The reported legal commercial catch of catfish for the lake (1950-1959) was 87,863 pounds valued in the rough at \$21,146. The average weight of catfish in the commercial seine hauls ranged from 1.8 pounds in 1958 to 3.4 pounds in 1952. The largest channel catfish examined in the investigation was 32.5 inches long and it weighed 16.75 pounds.

YELLOW BULLHEAD, *Ictalurus natalis* (Lesueur): Occasional.—Only very few specimens of this species were taken at Lake Chautauqua after 1953. Of the two largest yellow bullheads measured, one was 15.6 inches long (1.82 pounds) and the other was 15.0 inches long (2.10 pounds).

BROWN BULLHEAD, *Ictalurus nebulosus* (Lesueur): Common.—Most of the bullheads caught in the commercial seine hauls at Lake Chautauqua were brown bullheads. The majority of these fish weighed over 1 pound apiece. The largest brown bullhead handled was

15.6 inches long and weighed 1.80 pounds. The brown bullhead was not nearly so abundant as the channel catfish but was more abundant than the black bullhead.

BLACK BULLHEAD, *Ictalurus melas* (Rafinesque): Common.—This species was the most common bullhead taken by anglers at Lake Chautauqua. Commercial fishermen legally removed 1,452 pounds of bullheads, all species combined, from the lake in 1950-1959. Most of these fish were black bullheads and brown bullheads. The heaviest black bullhead handled was 14.4 inches long and it weighed 1.80 pounds.

FLATHEAD CATFISH, *Pylodictis olivaris* (Rafinesque): Rare.—Two flathead catfish weighing approximately 2 pounds apiece were taken by fishermen at Lake Chautauqua; they were identified by the senior author. Also, commercial fishermen reported catching a few pounds of flathead catfish in their wing nets. The flathead catfish occurs in the Illinois River and its large tributary streams and evidently strays only occasionally into Lake Chautauqua when there is high water.

TADPOLE MADTOM, *Noturus gyrinus* (Mitchill): Occasional.—This small catfish was of no direct value to the fishery at Lake Chautauqua. In one area of less than one-quarter acre to which rotenone was applied, 19 madtoms were collected. The largest specimen taken from the lake was 3.1 inches long.

Family Anguillidae

The American eel is the only member of its family occurring in Illinois waters. Very few eels are taken commercially in the state, and there is very little demand for them as food in Illinois.

AMERICAN EEL, *Anguilla rostrata* (Lesueur): Rare to occasional.—During the 5-year complete creel census program at Lake Chautauqua (1950-1954), anglers caught 21 eels. In 1954, trotline fishermen captured 8 eels. During the fall test-netting program, 8 eels were

caught; their sizes ranged from 27.5 inches long (1.82 pounds) to 39.0 inches long (4.75 pounds). The mesh of the nets usually used by commercial fishermen is too large to retain eels.

Family Cyprinodontidae

This family has several representatives in Illinois waters. However, only one species was taken in our collections at Lake Chautauqua.

BLACKSTRIPE TOPMINNOW, *Fundulus notatus* (Rafinesque): Rare.—One adult specimen of this species was collected from Lake Chautauqua with a minnow seine in 1958.

Family Poeciliidae

Forbes & Richardson (1920:216) reported taking *Gambusia affinis* (Baird & Girard) as far north as Pekin (probably 1903 or before); they reported the species as common in extreme southern Illinois. Krumholz (1948:5) mentioned a report that "Gambusia," or the mosquitofish, was taken in 1941 from the Illinois River at seven places between Pekin and the mouth of the river. In 1957, 10 mosquitofish were collected by us in a series of four minnow seine hauls at Lake Matanzas near Havana. These were the only mosquitofish we took in the Havana area in the 1950-1959 period. The mosquitofish was not collected from Lake Chautauqua; however, the presence of the species in nearby waters indicated that it might sometimes occur in Lake Chautauqua.

Family Percopsidae

In some parts of the United States, the trout-perch is usually considered as a fish found in deep waters where there is a sand or gravel bottom (Trautman 1957:465). In Illinois, however, this species is frequently taken in shallow waters over a soft mud bottom.

TROUT-PERCH, *Percopsis omiscomaycus* (Walbaum): Rare.—The trout-perch was taken with a minnow seine on three different occasions in Lake Chautauqua. This species has occurred

regularly in our minnow seine and electrofishing collections from the Illinois River. Seventeen trout-perch were taken by us in one minnow seine haul at nearby Quiver Lake in 1959.

Family Aphredoderidae

In central Illinois, the pirate perch is usually found only in small sluggish streams over mud bottom.

PIRATE PERCH, *Aphredoderus sayanus* (Gilliams): Rare.—A single adult pirate perch was taken in an area treated with rotenone at Lake Chautauqua in 1959.

Family Serranidae

This large family of sea basses is represented in Illinois waters by the white bass and the yellow bass. Both of these species are considered important sport fishes in the rivers of the state.

WHITE BASS, *Roccus chrysops* (Rafinesque): Common.—The size of the white bass population at Lake Chautauqua varied considerably from year to year during our investigation, and, as a result, the species was of only sporadic importance to anglers. In the 5 years of the complete creel census at Lake Chautauqua, the anglers' catch of white bass was as follows: 14 fish in 1950, 805 in 1951, 909 in 1952, 69 in 1953, and 319 in 1954 (Starrett 1958:43). Most of the white bass taken by anglers were 1- or 2-year-old fish. The largest white bass measured at Lake Chautauqua during this study was 16.3 inches long; it weighed 2.46 pounds.

YELLOW BASS, *Roccus mississippiensis* (Jordan & Eigenmann): Common to very abundant.—Fishing success for yellow bass at Lake Chautauqua varied from year to year and depended upon the size of the population and the water levels. Anglers usually had their best success in the spring months when the water was high. The best yellow bass fishing occurred in 1959, when the anglers' catch was estimated to be 13,000 fish. The yellow bass taken by anglers in most years were of satisfactory size; the average weight of yellow bass

caught by anglers was 0.46 pound. The largest yellow bass observed from Lake Chautauqua was caught by an angler in 1950; this fish was 12.2 inches long and it weighed 1.07 pounds.

Family Centrarchidae

Eight species of the sunfish family were collected in Lake Chautauqua during our investigation. Crappies and bluegills were the only members of the family that occurred abundantly in the lake. All eight species spawned in the lake with varying degrees of success.

SMALLMOUTH BASS, *Micropterus dolomieu* Lacépède: Possible occurrence.—Although Hansen (1942:198) reported the catch of a single smallmouth bass by an angler at Lake Chautauqua, he told us (personal communication, November 20, 1961) that he did not see this fish and suggested that we not accept his report as a positive record of occurrence of the smallmouth in Lake Chautauqua. We had a report from a boat liveryman that in 1950 a smallmouth bass had been taken in Lake Chautauqua and brought to his boatyard. Since we did not observe the smallmouth bass in any of our collections from Lake Chautauqua, we prefer to list the species as of only possible occurrence in the lake. The species is known to occur in some of the Illinois River tributary systems within the general area of Lake Chautauqua. However, to date, we have not taken the smallmouth bass in any of our collections from the Illinois River between Browning and Pekin. It is quite possible that a smallmouth bass could move from a tributary stream into the Illinois River and thence into Lake Chautauqua during a period of high water.

LARGEMOUTH BASS, *Micropterus salmoides* (Lacépède): Common.—In the years of our study, very few anglers came to Lake Chautauqua to fish specifically for largemouth bass. Most of the bass that were caught were taken by anglers fishing for bluegills and crappies (Starrett 1955:6). The annual

catch of largemouth bass taken by anglers in the period 1950-1954 ranged from 564 to 1,347 fish. Anglers took very few bass over 15.0 inches in length. Bass larger than 15.0 inches were scarce in our collections made with the various fishing devices employed in this study, including commercial seines. The largest bass handled from the lake was 20.2 inches long; it weighed 4.45 pounds.

WARMOUTH, *Chaenobryttus gulosus* (Cuvier): Common.—The warmouth never occurred abundantly in the lake during the 1950-1959 period. This species was of only minor importance as a sport fish. The largest warmouth measured was 8.3 inches long; it weighed 0.57 pound.

GREEN SUNFISH, *Lepomis cyanelus* Rafinesque: Common.—This species was taken less frequently by anglers than the warmouth. The largest green sunfish handled was 7.0 inches long; it weighed 0.30 pound.

PUMPKINSEED, *Lepomis gibbosus* (Linnaeus): Occasional.—This species was too scarce in Lake Chautauqua to be of any importance to the sport fishery. The largest pumpkinseed measured was 8.1 inches long; it weighed 0.56 pound.

BLUEGILL, *Lepomis macrochirus* Rafinesque: Very abundant.—The bluegill was one of the most important sport fishes occurring in Lake Chautauqua during our investigation. Bluegill fishing was particularly good at the lake in the years 1954-1958. In all years, the best bluegill fishing occurred in the months of May and June. In most years, anglers were pleased with the sizes of the bluegills they were able to catch (0.34 pound average). The largest bluegill observed during our study was 9.2 inches in length and 0.77 pound in weight.

ORANGESPOTTED SUNFISH, *Lepomis humilis* (Girard): Common.—Orangespotted sunfish in Lake Chautauqua seldom attained a size large enough to attract the interest of anglers. An orangespotted sunfish 4.8 inches long and

weighing 0.10 pound was kept by an angler. Nearly all of the specimens collected were taken with the minnow seine.

WHITE CRAPPIE, *Pomoxis annularis* Rafinesque: Very abundant.—The white crappie was one of the most abundant fishes occurring in Lake Chautauqua. This species spawned in the lake each year of our study except possibly 1953; however, the strength of year-classes was quite variable. The white crappie formed an important part of the anglers' catch, particularly in the years 1950-1956. In most years, it occurred in the lake much more abundantly than the black crappie. The average weight of white crappies taken by anglers was 0.41 pound. Very few white crappies were observed that weighed over a pound. The largest white crappie observed was 14.1 inches in length and 1.53 pounds in weight.

BLACK CRAPPIE, *Pomoxis nigromaculatus* (Lesueur): Very abundant.—The black crappie was usually less abundant at Lake Chautauqua than the white crappie. The average weight of the black crappie in the anglers' catches was 0.39 pound. The largest black crappie measured was 12.6 inches long; it weighed 1.38 pounds.

Family Percidae

Six species of fish of the perch family were taken at Lake Chautauqua in the period of our study. Only the yellow perch and the logperch were common in our collections.

SAUGER, *Stizostedion canadense* (Smith): Rare.—Only three saugers were collected at Lake Chautauqua in the period of our study; they were taken in our 1-inch-mesh wing nets. One specimen (13.7 inches long, 0.78 pound) was caught in October, 1952, and two more were taken in April, 1961 (13.7 inches long, 0.91 pound; 13.9 inches long, 0.90 pound). The last two specimens were nearly ripe females. The saugers collected at Lake Chautauqua evidently came into the lake from the

Illinois River during high water. Saugers are now caught occasionally in the river by commercial fishermen. We have not collected any young-of-the-year saugers from the lake or from the river in the Havana area.

YELLOW PERCH, *Perca flavescens* (Mitchill): Common.—Earlier in this paper, we mentioned that the yellow perch was formerly abundant in Lake Chautauqua. In the period 1950–1959, perch spawned in the lake in most years but failed during this period to produce a single large year-class. We attributed this poor spawning success to the lack of submergent vegetation during the spawning season. Prior to 1943, submergent vegetation flourished in the lake, and the yellow perch was abundant and formed an important part of the anglers' catch (Hansen 1942:198). Fishing was very poor for perch in the 1950–1959 period. The anglers' annual catches of the yellow perch in the years 1950–1954 ranged from 194 to 806 fish. The perch caught by anglers were usually of a size satisfactory to them. The largest yellow perch we observed was 11.5 inches long; it weighed 0.70 pound.

RIVER DARTER, *Percina shumardi* (Girard): Rare.—A single specimen of this species was taken in a minnow seine haul at the lake in 1959. Our identification of this specimen was confirmed by Dr. Milton B. Trautman of Ohio State University (personal communication, January 22, 1960).

LOGPERCH, *Percina caprodes* (Rafinesque): Common.—This was the only species of darter taken regularly in our collections at Lake Chautauqua. Young-of-the-year logperch were taken in several different years. Seven specimens of this species were submitted to Dr. Reeve M. Bailey of the University of Michigan for examination. He informed us (personal communication, March 4, 1960) that the specimens from Lake Chautauqua appeared to be of a subspecies intermediate between *P. caprodes carbonaria* and *P. caprodes semifasciata*.

BLUNTNOSE DARTER, *Etheostoma chlorosomum* (Hay): Rare to occasional.—Nineteen specimens of this species were collected from Lake Chautauqua through our use of rotenone and minnow seines. This darter possibly spawned in Lake Chautauqua, as evidenced by several small specimens taken in our collections.

MUD DARTER, *Etheostoma asprigene* (Forbes): Rare.—Forbes & Richardson (1920:307–309) reported that the mud darter, known to them as *Etheostoma jessiae*, was very common in the Illinois River at Havana (probably 1903 or before). This species has occurred only occasionally in our collections from the Illinois River at Havana. Three specimens of the mud darter were collected at Lake Chautauqua; these were taken in areas treated with rotenone.

Family Sciaenidae

The freshwater drum is the only representative in Illinois of a large family of marine fishes. This drum, known in Illinois as the white perch and the sheepshead, is of importance as both a commercial and sport fish in the Illinois River and the Mississippi River.

FRESHWATER DRUM, *Aplodinotus grunniens* Rafinesque: Very abundant.—The freshwater drum was one of the most abundant fishes in Lake Chautauqua during our study. In most years of our study, this species spawned quite successfully in the lake. The drum formed an important part of the creel in years of high water levels. Starrett & McNeil (1952:22–23) reported that the best fishing conditions for the drum in 1950 and 1951 were in periods of high or rising water. In 1950, an exceptionally good year for drum fishing because of the high water levels, anglers caught 9,459 drum. The drum comprised 15.2 per cent by weight of the legal reported commercial catch at Lake Chautauqua in the years 1950–1959. In this period, commercial fishermen removed from the lake 312,946 pounds of drum valued at \$19,807. The largest drum caught

during the investigation was 28.2 inches long; it weighed 11.64 pounds. The average weight of individuals in the commercial seine hauls ranged from 0.94 pound in 1956 and 1958 to 1.46 pounds in 1954.

Family Atherinidae

Only one member of this family occurs in Illinois waters.

BROOK SILVERSIDE, *Labidesthes sicculus* (Cope): Scarce to abundant.—The numbers of this species caught in the minnow seine collections varied considerably from year to year (0.0 to 20.9 fish per haul). The species was most abundant in 1950, 1957, and 1958. In those years, it was probably of some importance as a forage fish because of the size and abundance of individuals.

GROWTH AND AGE OF FISHES

From the age and length data collected during our investigation of Lake

of the fish. For example, a fish collected in September with scales or spine showing two annuli plus a summer's growth was called a 3-year-old fish and was placed in age group III of Fig. 7-16.

BLUEGILL GROWTH RATES.—Age and length data for the Lake Chautauqua bluegills we studied in 1950-1959 are summarized in Tables 6-9.

The size distribution of young bluegills taken in the 1959 minnow seine and rotenone collections (Table 6) was rather typical of the distribution found in the collections made in previous years. The data indicated evidence of at least two major spawning periods in 1959. By early fall, the majority of the young bluegills in the minnow seine collection were 1.0-2.0 inches in length. The calculated first-year growth of bluegills of four different year-classes averaged 1.8 inches in length (Table 7). The first year's growth of bluegills at Lake Chautauqua was considered as

Table 6.—Number of bluegills of less than 1 year old in each of several size groups in the 1959 minnow seine and rotenone collections at Lake Chautauqua.

Date of Collection	Total Length of Individual Fish in Inches					Number of Fish Measured
	0.5	1.0	1.5	2.0	2.5	
July 10°	33	36	0	0	0	69
August 12†	0	4	71	15	0	90
August 12°	0	5	27	1	0	33
August 27°	6	66	57	18	0	147
September 17°	0	75	141	19	0	235
October 8°	1	66	88	58	1	214

°Minnow seine sample.
†Rotenone sample.

Chautauqua, we determined the growth rates of 14 species of fishes and the age composition of the catch of 9 species.

Growth Rates of Species

The statistics pertinent to the growth rates of 14 species of fishes collected at Lake Chautauqua in the period 1950-1959 are presented in this section. In determining growth rates of a fish, we considered a growing season, ending August 31, equivalent to a year of life

Table 7.—Average calculated total length, in inches, of Lake Chautauqua bluegills of each of four year-classes at ages of 1 year and 2 years.

Year Class	Age of Fish		Number of Fish
	1 Year	2 Years	
1948	1.8	4.7	58
1950	1.5	4.4	16
1952	1.9	5.1	46
1955	2.0	5.1	78
Average or total	1.8	4.8	198

being only fair compared with growth made by bluegills in Clear Lake, Iowa. Di Costanzo (1957:23) determined the

first year's growth of bluegills in that lake to be 2.39 inches. The average first year's growth in 56 northern Indi-

Table 8.—Average observed lengths and weights of bluegills of various ages, excluding 1-year-old fish, at Lake Chautauqua.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish Aged
2	4.7	3.8–5.2	0.08	0.03–0.11	235
3	6.2	5.6–6.5	0.22	0.17–0.29	1,299
4	7.1	6.9–7.3	0.34	0.27–0.40	1,461
5	7.8	7.4–8.1	0.45	0.35–0.52	728
6	8.5	8.3–8.6	0.56	0.46–0.64	108
7	9.1	9.0–9.2	0.74	0.67–0.77	4
Total	..	....	...	....	3,835

*Range based on mean annual lengths or weights.

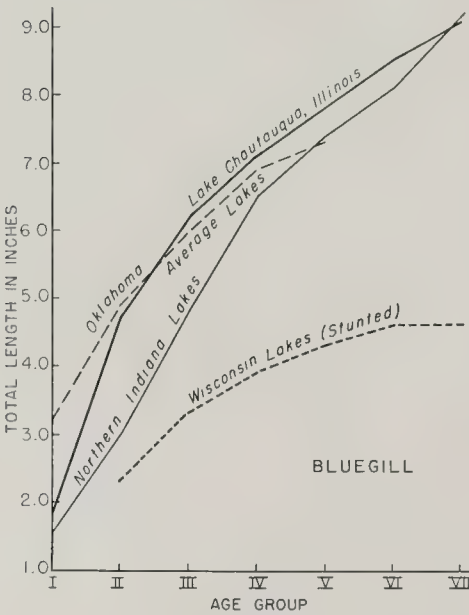


Fig. 7.—Growth of bluegills in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in the text and on Table 8 (except that length of 1-year-old fish at Lake Chautauqua was calculated). It indicates that Lake Chautauqua bluegills had excellent growth rates after their first year of life. It was not intended to give the impression that bluegills at Lake Chautauqua had better growth rates than those of all other waters. Some other waters, particularly newly created lakes and ponds, have produced bluegills with better growth rates than the Lake Chautauqua bluegills.

Table 9.—Average total lengths (inches) of bluegills of various ages for each year, 1949–1959, at Lake Chautauqua.

Year	3-Year-Old Fish	4-Year-Old Fish	5-Year-Old Fish
1949	6.2	7.3	8.1
1950	6.0	7.0	7.9
1951	6.1	7.2	7.8
1952	5.6	6.9	7.7
1953	6.0	7.1	7.9
1954	6.5	7.1	7.7
1955	6.3	7.3	7.9
1956	6.2	7.2	8.0
1957	6.5	7.2	8.0
1958	6.2	6.9	7.4
1959	6.4	7.2	7.7
Average	6.2	7.1	7.8

ana lakes was 1.5 inches (Ricker 1942; data summarized by Carlander 1953: 184).

After the first year, the growth rates of bluegills in Lake Chautauqua were very good compared with the growth rates of bluegills in other midwestern bodies of water not newly created (Table 8; Fig. 7; Bennett 1945:395; Jenkins, Elkin, & Finnell 1955:14; Ricker 1942; Snow, Ensign, & Klingbiel 1960:7; Upper Mississippi River Conservation Committee 1946:20; and others). Very few bluegills lived more than 6 years

in Lake Chautauqua, our study showed. Throughout our entire study period, only four bluegills were found that had reached an age of 7 years (Table 8). Schloemer (1939:13, 60), who examined scales of 115 bluegills collected from Lake Chautauqua in 1936, did not find any of the fish to be over 5 years of age. He aged too few bluegills from Lake Chautauqua over 2 years of age (12 fish) to give any real comparison with the age data in the present study.

Average sizes attained by bluegills each year in the period 1949-1959 are presented in Table 9. Data in the table show that the 3-year-old fish tended to vary in size slightly more from year to year than did the 4- and 5-year-old fish. Because in most years too few 2- and 6-year-old fish were aged to furnish information of much value to this study, fish in these age-groups were not included in Table 9.

LARGEMOUTH BASS GROWTH RATES.—The age determinations for the bass collected at Lake Chautauqua in 1950-

1959 indicated that the growth rates of these bass were fairly good compared with the growth rates of bass in some other waters (Table 10; Fig. 8; Beckman 1949:78; Bennett 1937:107; Jenkins & Hall 1953:18; McCaig & Mullan 1960:29; Schoffman 1953:4; Stroud 1948:61; and others). As indicated in Table 10, very few bass from Lake Chautauqua were found that had lived more than 4 years, and no bass more than 7 years of age were found. Natural mortality rather than poor growth was believed responsible for the scarcity of large bass in Lake Chautauqua.

WARMOUTH GROWTH RATES.—A summary of age determinations made from scales of warmouths collected during the Lake Chautauqua study is presented in Table 11. The growth rates of Lake Chautauqua warmouths aged by us in the present study were much better than the growth rates of the Lake Chautauqua warmouths aged by Larimore (1957:65). Larimore aged only 30 warmouths from this lake. Perhaps his sample was too small or he had sampled a different segment of the population at Lake Chautauqua. The growth rates of Lake Chautauqua warmouths we aged were quite good for warmouths of Illinois waters (Larimore 1957:65). The

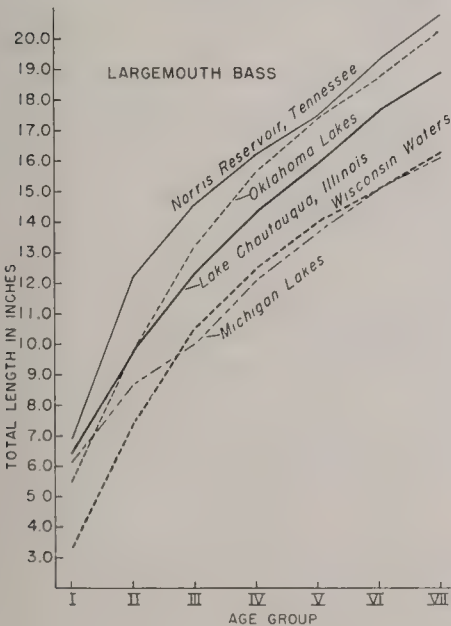


Fig. 8.—Growth of largemouth bass in Lake Chautauqua and in certain other waters of the United States. The graph is based on references included in text and on Table 10.

Table 10.—Average observed lengths and weights of largemouth bass of various ages at Lake Chautauqua, 1950-1959.

Age in Years	Total Length in Inches	Average Weight in Pounds	Number of Fish
1	6.4*	0.15*	62
2	9.8	0.51	252
3	12.3	1.05	120
4	14.3	1.69	41
5	15.9	2.32	16
6	17.7	3.29	11
7	18.9	4.20	3
Total	...	...	505

*Figures probably not representative of the age group, as many of the fish were taken by angling. Angling probably sampled only that segment of the population represented by the largest members of the 1-year-old brood.

Table 11.—Average observed lengths and weights and calculated lengths of warmouths of various ages at Lake Chautauqua, 1950–1959.

Age in Years	Observed			Calculated	
	Total Length in Inches	Average Weight in Pounds	Number of Fish	Total Length in Inches	Number of Fish
1	..	..	0	1.5	98
2	4.7	0.08	9	3.9	98
3	5.4	0.13	65	5.5	98
4	6.3	0.22	74	6.4	95
5	6.9	0.32	29	7.0	33
6	8.1	0.53	2	8.1	2
Total	..	...	179	..	.

oldest warmouths we aged from Lake Chautauqua were 6 years old.

PUMPKINSEED GROWTH RATES.—Age data for the relatively few pumpkinseeds we collected from Lake Chautauqua are presented in Table 12. Our data

Table 12.—Average observed lengths and weights of pumpkinseed of various ages at Lake Chautauqua, 1950–1959.

Age in Years	Total Length in Inches	Average Weight in Pounds	Number of Fish
2	4.1	0.06	2
3	5.6	0.16	21
4	6.5	0.26	25
5	7.1	0.33	8
6	8.1	0.56	1
Total	..	...	57

Table 13.—Average observed lengths and weights of green sunfish of various ages at Lake Chautauqua, 1950–1959.

Age in Years	Total Length in Inches	Average Weight in Pounds	Number of Fish
2	4.2	0.05	7
3	5.5	0.15	25
4	6.5	0.25	15
5	7.1	0.27	1
Total	..	...	48

indicate that the growth rates of the pumpkinseed in Lake Chautauqua were comparatively good for the species in midwestern lakes (Table 12; Beckman 1949:72; Di Costanzo 1957:31; and others).

GREEN SUNFISH GROWTH RATES.—Scales were collected from only 48 green sunfish at Lake Chautauqua during the fall and spring months of the 1950–1959 period. The results of age determinations from these scales are presented in Table 13. If we can judge the growth rates of the green sunfish from this limited sample of scales, then the growth rates of the species in Lake Chautauqua were good compared with its growth rates in other midwestern waters (Bennett 1945:398; Cross, Deacon, & Ward 1959:164; Purkett 1958:36; Sprugel 1955:714; and others).

WHITE CRAPPIE GROWTH RATES.—The age and growth data on white crappies of 2 years and older collected at Lake Chautauqua in 1950–1959 are summarized in Tables 14–16.

One-year-old white crappies taken in our test-net and minnow seine collections ranged from 3.0 to 4.0 inches in length. The average growth rate of white crappies of 2 years and older at Lake Chautauqua was quite good compared with growth rates of white crappies of the same ages in other waters (Table 14; Fig. 9; Hall, Jenkins, & Fin-

nell 1954:7; Hansen 1951:252; Lewis Stroud 1949:68; and Witt 1952:177).
1950a:310; Purkett 1958:19; Ricker & Fish over 5 years of age were not com-
Lagler 1942:89; Schoffman 1960:5; mon in any of our white crappie collec-

Table 14.—Average observed lengths and weights of white crappies of various ages at Lake Chautauqua, 1949–1959.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish
2	7.5	6.3– 8.3	0.23	0.12–0.31	1,952
3	9.3	8.6– 9.9	0.44	0.30–0.57	1,854
4	10.4	10.0–10.8	0.63	0.52–0.72	860
5	11.1	10.9–11.4	0.79	0.73–0.82	589
6	11.8	11.3–12.2	0.93	0.85–1.01	177
7	12.8	11.6–14.1	1.16	0.88–1.51	26
Total	...	.....	...	.....	5,458

*Range based on mean annual lengths or weights.

Table 15.—Average total lengths of white crappies of various ages at Lake Chautauqua, 1950–1959.

Year	Age of Fish in Years				
	2	3	4	5	6
1950	6.6	8.9	10.4	11.2	12.2
1951	6.9	8.6	10.0	11.0	11.8
1952	6.3	9.0	10.1	10.8	11.3
1953	8.1	9.7	10.4	11.1	11.3
1954	8.3	9.6	10.4	11.1	11.6
1955	7.2	9.5	10.5	11.1	11.7
1956	7.8	9.5	10.8	11.4	12.0
1957	8.0	9.3	10.2	11.1	12.1
1958	8.0	8.8	10.4	...	...
1959	8.1	8.9	10.0	10.9	...
Average	7.5	9.2	10.3	11.1	11.8

Table 16.—Sex ratios of white crappies of various ages; data from a sample of 401 fish taken March 24–April 2, 1954, in commercial wing nets at Lake Chautauqua.

Age in Years	Male		Female		Number of Fish
	Total Length in Inches	Per Cent of Collection Males	Total Length in Inches	Per Cent of Collection Females	
3	10.0	47.3	9.9	52.7	226
4	10.6	51.1	10.7	48.9	94
5	11.2	33.3	11.2	66.7	24
6	11.2	10.5	11.5	89.5	57
Total	...	...	...	...	401

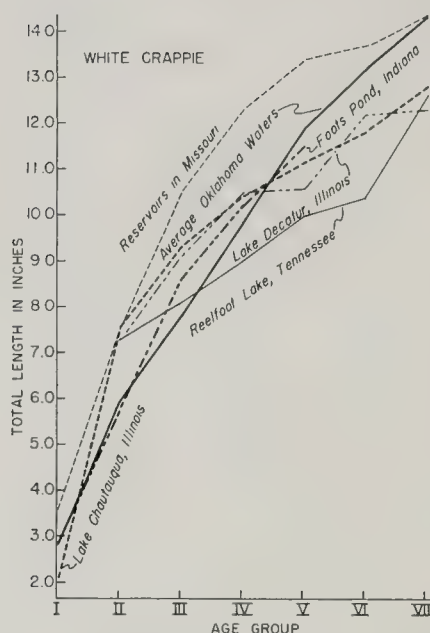


Fig. 9.—Growth of white crappies in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in the text and on Table 14 (except that length of 1-year-old fish at Lake Chautauqua was calculated).

tions. Only 26 of the white crappies that we examined had attained 7 years of age, and all but 4 of these fish were survivors of the large 1948 year-class.

After 1952, considerable increase occurred in the average lengths of Lake Chautauqua white crappies in their second summer of life (Table 15). The older fish also showed some increases in length after 1952 but did not maintain these increases in the later years of the investigation, as did the 2-year-old fish.

There appeared to be little or no difference in growth rates between the sexes of the 3-year-old and older white crappies at Lake Chautauqua (Table 16). The sex ratios of the 3- and 4-year-old fish considered together indicated a slight predominance of females. The comparatively large sample of 6-year-old white crappies showed that the females lived longer than the males. Hansen (1951:230-232) found at Lake De-

catur, Illinois, that in the young white crappies he examined the number of males was greater than the number of females. He found a predominance of females in the fish older than 2 years of age. Witt (1952:119) determined from his study of reservoirs in Missouri, other than Niangua, that the female white crappie outlived the male.

BLACK CRAPPIE GROWTH RATES.—In our investigation, 3,070 black crappies from Lake Chautauqua were aged (Tables 17 and 18). Apparently, very few black crappies in Lake Chautauqua lived more than 5 years. Most of the black crappies, as well as the white crappies, taken from the lake were less than 5 years of age. We took no fish of either species more than 7 years old. Our findings on age composition of the crappie populations were quite similar to those of Hall, Jenkins, & Finnell (1954:7, 23) in Oklahoma and Stroud

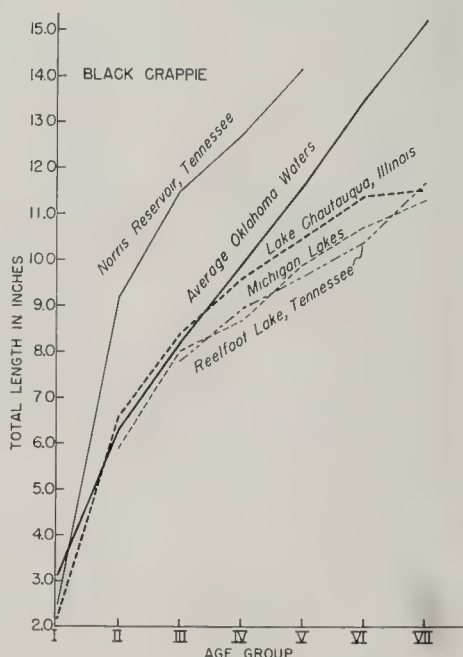


Fig. 10.—Growth of black crappies in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in the text and on Table 17 (except that length of 1-year-old fish was calculated).

(1948:67) in Tennessee. The studies of Huish (1958:302) in the Southeast indicated that black crappies with slow growth tended to live longer than those with fast growth. The fast growth of the crappies in Oklahoma, Tennessee, and Lake Chautauqua may have affected their life span.

One-year-old black crappies captured by minnow seine and test nets at Lake Chautauqua ranged from 3.0 to 4.0 inches in length. The growth rate of black crappies after their first year of life in Lake Chautauqua compared favorably with the growth rates of black crappies in other states (Table 17; Fig. 10; Beckman 1949:76; Hall, Jenkins, &

Finnell 1954:23; Lewis 1950a:307; Purkett 1958:18; Schoffman 1940:28; and Stroud 1948:74 and 1949:67). The average lengths of black crappies of Lake Chautauqua at various ages are presented in Table 18. The average lengths of 2- and 3-year-old black crappies were slightly greater after 1952 than before. The average lengths of the older fish varied from year to year, as shown in Table 18.

YELLOW PERCH GROWTH RATES.—Few of the Lake Chautauqua perch that we aged had lived more than 4 years (Table 19). Parsons (1950:88) found that only a small percentage of the perch from Clear Lake, Iowa, were over 3

Table 17.—Average observed lengths and weights of black crappies of various ages at Lake Chautauqua, 1950–1959.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish
2	6.6	5.8– 7.2	0.16	0.10–0.22	835
3	8.4	7.7– 9.2	0.35	0.23–0.51	1,022
4	9.6	9.0–10.2	0.53	0.47–0.67	776
5	10.5	9.9–10.9	0.71	0.54–0.77	331
6	11.3	10.8–11.8	0.90	0.83–1.07	97
7	11.5	11.2–11.7	0.91	0.84–0.97	9
Total					3,070

*Range based on mean annual lengths or weights.

Table 18.—Average total lengths of black crappies of various ages at Lake Chautauqua, 1950–1959.

Year	Age of Fish in Years				
	2	3	4	5	6
1950	6.0	7.7	10.0	10.9	11.7
1951	5.9	7.9	9.3	10.7	11.8
1952	5.8	7.8	9.1	9.9	11.8
1953	6.7	8.3	9.0	10.1	10.8
1954	7.2	8.5	9.5	10.4	
1955	7.1	9.2	9.8	10.3	11.0
1956	6.8	9.2	10.2	10.8	11.2
1957	7.1	8.5	9.7	10.7	11.3
1958	6.4	8.5	9.6	10.8	
1959	6.6	8.3	9.4	10.6	11.2
Average	6.6	8.4	9.6	10.5	11.3

Table 19.—Average observed lengths and weights of yellow perch of various ages at Lake Chautauqua, 1950–1959.

Age in Years	Total Length in Inches	Average Weight in Pounds	Number of Fish
2	7.1	0.16	23
3	8.3	0.29	52
4	9.7	0.44	52
5	10.7	0.60	2
Total	...	...	129

years old. He mentioned that in most populations perch are not particularly a long-lived fish. The growth rates of yellow perch at Lake Chautauqua, as shown by a limited sample, were at least fairly good compared with growth rates of perch elsewhere in the United States (Table 19; Beckman 1949:70; Jobes 1952:227; Lewis 1950a:313; McCaig & Mullan 1960:29; Van Oosten & Deason 1957:43; and others).

CHANNEL CATFISH GROWTH RATES.—The spines we used for aging channel catfish were collected from individuals taken in the commercial seine hauls during the month of September, 1953–

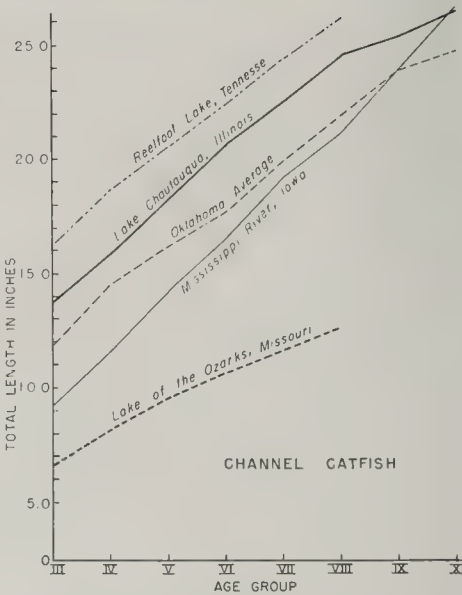


Fig. 11.—Growth of channel catfish in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in text and on Table 20.

1958 (Tables 20 and 21). The large mesh size of commercial seines used and the 13.0-inch size limit on catfish taken with commercial fishing devices in Illinois virtually eliminated young fish from our collections. Consequently,

Table 20.—Average observed lengths and weights of channel catfish of various ages at Lake Chautauqua, 1953–1958.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish
3	13.7	13.2–14.4	0.79	0.69– 0.91	268
4	15.8	15.2–16.8	1.29	1.13– 1.59	865
5	18.2	17.8–18.8	2.10	1.93– 2.32	519
6	20.6	19.6–21.2	3.22	2.74– 3.43	221
7	22.4	20.3–23.6	4.38	2.87– 5.17	105
8	24.6	22.6–25.9	5.91	4.63– 6.65	65
9	25.3	24.5–27.0	6.56	5.67– 7.97	39
10	26.5	23.9–29.2	7.98	5.46–10.75	24
11	26.6	23.2–27.8	8.41	4.21–10.28	11
12	28.1	26.6–29.2	10.16	6.79–12.50	4
13	...	.....	...	.....	0
14	30.5	.....	13.50	.....	1
15	28.8	26.5–31.1	11.75	8.37–15.13	3
Total	...	.....	...	.....	2,065

*Range based on mean annual lengths or weights.

Table 21.—Average total lengths of channel catfish of various ages at Lake Chautauqua, 1953–1958.

Year	Age of Fish (Years)				
	3	4	5	6	7
1953	...	15.4	17.9	20.5	23.3
1954	13.2	15.6	17.9	20.8	23.4
1955	14.0	16.0	18.4	21.2	23.6
1956	14.4	16.8	18.5	20.3	21.8
1957	13.2	15.9	18.8	19.6	20.3
1958	13.7	15.2	17.8	20.9	21.8
Average	13.7	15.8	18.2	20.6	22.4

the 13.7 inches total length average for the Lake Chautauqua 3-year-old channel catfish was biased because of the scarcity of fish under 13.0 inches in our samples. The growth rates of channel catfish in Lake Chautauqua were excellent compared with the growth rates of these catfish in some other waters of the mid-continent (Tables 20 and 21; Fig. 11; Appelget & Smith 1951:123; Finnell & Jenkins 1954:10; Schoffman 1954:5; Marzolf 1955:247; Harrison 1957:662; and Muncy 1959:130). Data on the average lengths of Lake Chautauqua channel catfish of various ages (Table 21) indicate that only minor variations occurred in the year-to-year growth rates of these catfish.

FRESHWATER DRUM GROWTH RATES.—The scales used for aging 2,345 freshwater drum at Lake Chautauqua were collected from fish taken in the commercial seines used on the lake each September, 1951–1958. Age and growth information is given in Tables 1 and 22. The average length of 9.7 inches shown in Table 22 for 2-year-old fish is probably too high because of two known biases in our samples. In Illinois, it is illegal to take drum under 10.0 inches in length (undressed) with commercial fishing devices. The large mesh size of the seines used on the lake allowed the escape of most of the drum under 9.0 inches in length. The drum aged in this study as 2-year-olds, and to a lesser extent the drum aged as 3-year-olds, were

probably the largest members of their year-classes.

The growth rates of drum at Lake Chautauqua were fair compared with growth rates recorded from some other waters (Tables 1 and 22; Fig. 12; Butler & Smith 1950:51; Greer & Cross 1956:362; Houser 1960a:10 and 1960b:11; Jenkins 1951:92; Schoffman 1941:108; and Van Oosten 1938:656). The average lengths of drum of various

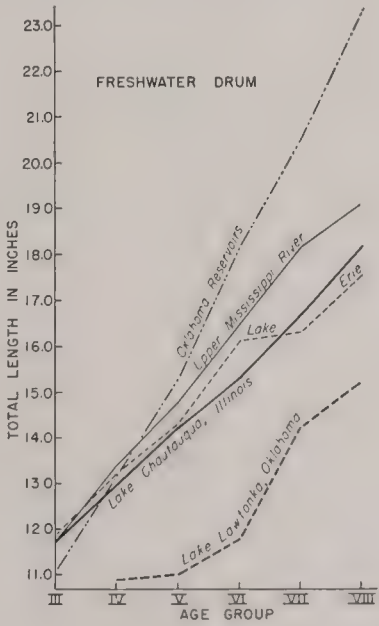


Fig. 12.—Growth of freshwater drum in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in text and on Table 22.

Table 22.—Average observed lengths and weights of freshwater drum of various ages at Lake Chautauqua, 1951–1958.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish
2	9.7	9.1–10.4	0.41	0.33–0.53	159
3	11.7	11.2–11.9	0.74	0.64–0.79	492
4	12.9	12.4–13.2	1.04	0.88–1.14	636
5	14.2	13.7–14.5	1.37	1.14–1.55	646
6	15.3	14.8–15.7	1.72	1.40–1.94	303
7	16.7	16.2–17.5	2.18	1.77–2.56	87
8	18.2	17.4–20.0	2.77	2.30–3.86	15
9	18.9	18.6–19.2	3.00	2.59–3.40	2
10	21.6	19.5–21.6	4.55	3.56–5.53	2
11	23.3	.....	8.46	.....	1
12	23.8	.....	7.81	.....	1
13	...	.....	...	.....	0
14	28.2	.....	11.64	.....	1
Total	...	.....	...	.....	2,345

*Range based on mean annual lengths or weights.

ages (Table 1) show that some variations occurred from year to year in growth rates of the species in Lake Chautauqua. The average lengths indicated particularly poor growth rates in the fish caught in 1955 and 1956.

BIGMOUTH BUFFALO GROWTH RATES.
—The scales used in aging the Lake

Chautauqua bigmouth buffalo were collected each September of our study from fish taken with commercial seines. The average observed lengths of bigmouth buffalo of various ages are presented in Tables 23 and 24. Most of the buffalo in the commercial seine hauls were 3 to 8 years of age (Table 23).

Table 23.—Average observed lengths and weights of bigmouth buffalo of various ages at Lake Chautauqua, 1951–1958.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish
2	11.8	10.8–12.9	0.96	0.72– 1.14	38
3	15.3	14.8–15.7	2.12	1.85– 2.33	233
4	17.0	16.7–17.5	2.97	2.79– 3.16	606
5	18.9	18.4–19.3	4.27	3.85– 4.54	604
6	20.7	20.0–21.0	5.67	5.18– 5.94	420
7	22.2	21.7–22.9	7.04	6.76– 7.64	247
8	23.3	23.0–23.9	8.49	8.01– 9.48	157
9	24.5	24.1–24.9	9.95	9.65–10.51	118
10	25.7	25.2–26.5	11.59	10.61–13.75	97
11	26.5	24.8–27.6	12.93	10.92–14.17	78
12	27.5	26.9–28.1	14.43	13.25–15.63	66
13	28.9	27.5–30.6	16.89	15.00–19.75	44
14	29.3	27.9–30.5	18.18	16.88–20.38	25
15	30.3	29.2–31.0	19.85	18.42–22.00	15
16	30.7	30.5–30.9	22.88	22.00–23.50	6
17	31.0	.....	18.25	.....	1
Total	...	.....	...	.....	2,755

*Range based on mean annual lengths or weights.

The growth rates of the 2- and 3-year-old bigmouth buffalo at Lake Chautauqua were very good. However,

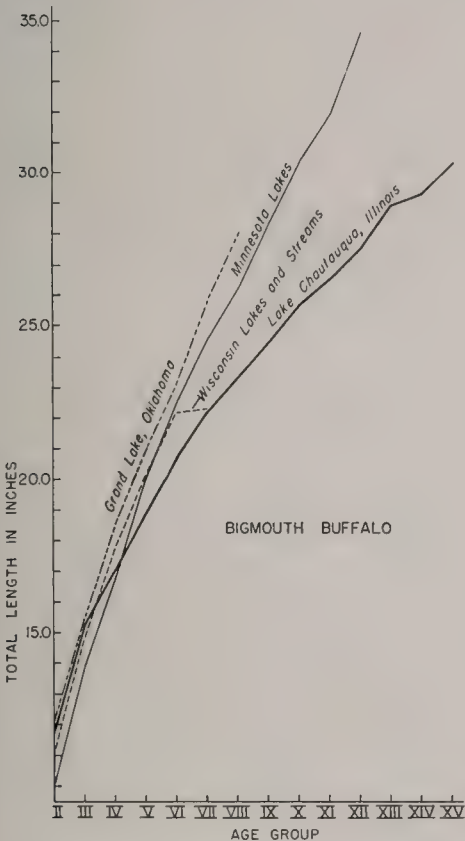


Fig. 13.—Growth of bigmouth buffalo in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in text and on Table 23.

the growth rates of the older fish of this species were only fair compared with the growth rates of comparable individuals in other waters (Tables 23 and 24; Fig. 13; Eddy & Carlander 1939:9 and 1942:21; Frey & Pedracine 1938:516, species of buffalo not separated; Gowanlock 1951:12; Greer & Cross 1956:359; Jenkins 1953:61; Jenkins, Leonard, & Hall 1952:77; and Schoffman 1943:39). Variations in the growth rates from year to year were very slight, as indicated by average lengths in Table 24.

CARP GROWTH RATES.—The difficulties involved in aging carp from scales have been discussed by Frey (1942: 217) and others. In the present study, we aged carp from cross sections of the dorsal spine. We do not place complete confidence in our age determinations, since the method we used apparently has not been validated with fish of known ages.

A summary of the carp age determinations we made from dorsal spines is presented in Table 25. The growth rates of Lake Chautauqua carp should perhaps be regarded as intermediate compared with the growth rates of carp in some other waters (Table 25; Fig. 14; English 1952:534; Jackson 1955:13; Jenkins 1953:73; McConnell 1952:146; Patriarche 1953:249; Purkett 1958:10; Schoffman 1942:71; and Thompson 1950:29). The average annual weight

Table 24.—Average total lengths of bigmouth buffalo of various ages at Lake Chautauqua, 1951–1958.

Year	Age of Fish (Years)							
	3	4	5	6	7	8	9	10
1951	15.4	17.1	19.0	20.8	22.9	23.7	24.5	25.7
1952	14.8	16.9	18.7	20.5	22.0	23.0	24.3	25.6
1953	14.9	16.7	19.0	20.8	22.5	23.9	24.9	25.6
1954	15.4	17.5	19.2	21.0	22.0	23.1	24.8	25.3
1955	15.7	16.9	19.0	20.6	21.8	23.2	24.4	25.9
1956	15.6	17.1	19.3	20.9	22.7	23.1	24.7	26.5
1957	15.1	16.8	18.7	20.6	21.7	23.0	24.1	25.2
1958	15.4	16.7	18.4	20.0	21.9	23.1	24.4	25.6
Average	15.3	17.0	18.9	20.7	22.2	23.3	24.5	25.7

increment of carp after the second year through the sixth year at Lake Chautauqua was about 1 pound.

WHITE BASS GROWTH RATES.—Age and growth data for the white bass at

Lake Chautauqua in the period 1950–1958 are summarized in Table 26. The growth rates of these fish were about average compared with the growth rates of white bass in some other waters of the United States (Table 26; Fig. 15; Lewis 1950*b*:274; Jenkins & Elkin 1957:7; Patriarche 1953:249; Sigler 1949*a*:217 and 1949*b*:313; Thompson 1951:107; Tompkins & Peters 1951:8; Upper Mississippi River Conservation Committee 1946:20; Van Oosten 1942:316; and Ward 1951:78). The white bass in Lake Chautauqua were short-lived. Very few were found that had

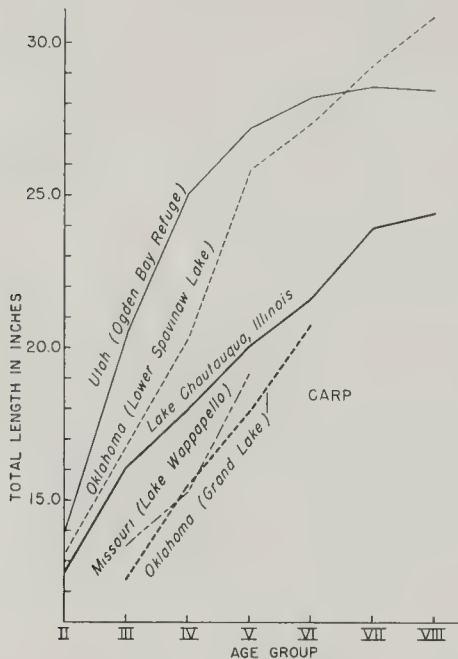


Fig. 14.—Growth of carp in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in the text and on Table 25.

Table 25.—Average observed lengths and weights of carp of various ages at Lake Chautauqua, September of 1957 and 1958.

Age in Years	Average Total Length in Inches	Average Weight in Pounds	Number of Fish
2	12.6	1.08	59
3	16.1	2.02	33
4	18.0	2.88	46
5	20.1	3.89	40
6	21.6	4.88	21
7	23.9	6.74	16
8	24.4	7.41	7
9	27.5	10.42	9
10	27.3	10.20	14
11	28.7	11.42	5
12	30.9	15.83	3
Total	...	....	253

Table 26.—Average observed lengths and weights of white bass of various ages at Lake Chautauqua, 1950–1958.

Age in Years	Average Total Length in Inches	Average Weight in Pounds	Number of Fish
1	7.2	0.19	194
2	11.4	0.76	316
3	13.1	1.20	223
4	14.2	1.50	119
5	15.6	2.04	14
Total	...	...	866

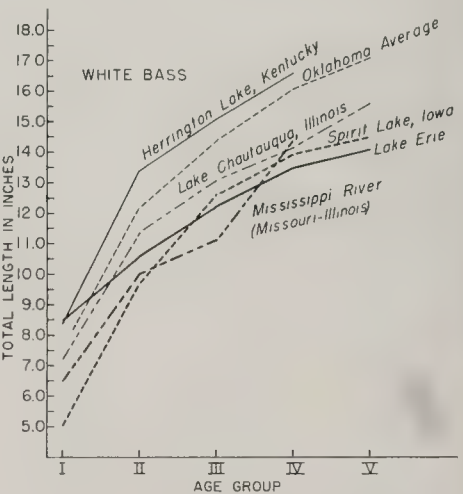


Fig. 15.—Growth of white bass in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in text and on Table 26.

Table 27.—Size distribution of young-of-the-year yellow bass in the 1958 minnow seine haul collections at Lake Chautauqua.

Date of Collection	Number of Fish of Indicated Total Length in Inches						Total Number of Fish
	1.0	1.5	2.0	2.5	3.0	3.5	
July 2	1	18	3	0	0	0	22
July 11	0	21	12	0	0	0	33
July 18	0	6	129	4	0	0	139
August 28	0	0	1	5	41	2	49

Table 28.—Average lengths and weights of yellow bass of various ages at Lake Chautauqua, 1950–1952, 1954, and 1957–1959.

Age in Years	Average Total Length in Inches	Range in Length, Inches*	Average Weight in Pounds	Range in Weight, Pounds*	Number of Fish
2	7.1	7.0– 7.4	0.18	0.15–0.20	192
3	8.4	8.1– 8.7	0.31	0.28–0.38	309
4	9.5	9.1– 9.7	0.46	0.39–0.54	225
5	10.3	10.1–10.6	0.61	0.51–0.72	308
6	11.0	10.6–11.3	0.74	0.61–0.81	195
7	11.7	11.5–12.0	0.92	0.87–0.96	12
Total	...	.....	...	.....	1,241

*Range based on mean annual lengths or weights.

lived more than 3 years. A similar situation was noted in Lake Erie by Van Oosten (1942:313). The oldest white bass taken from Lake Chautauqua were 5 years of age (Table 26).

YELLOW BASS GROWTH RATES.—The lengths of young-of-the-year yellow bass at Lake Chautauqua in the summer of 1958 are presented in Table 27. These data indicate that most of the

young fish were 3.0 inches long by late August. At Lake Chautauqua, spawning by the yellow bass occurred in late

Table 29.—Average total lengths of yellow bass of various ages at Lake Chautauqua, each spring, 1950–1952, 1954, and 1957–1958.

Year	Age of Fish (Years)				
	2	3	4	5	6
1950	7.4	8.4	9.7	10.3	11.2
1951	7.0	8.4	9.1	10.2	10.8
1952	7.0	8.7	9.6	10.4	11.0
1954	..	8.1	9.4	10.2	10.8
1957	7.0	8.5	9.7	10.6	11.2
1958	7.1	8.4	9.5	10.1	11.3
1959	7.1	8.5	9.3	10.1	10.6
Average	7.1	8.4	9.5	10.3	11.0

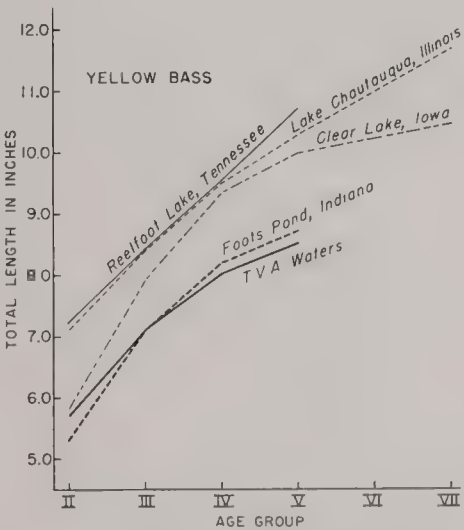


Fig. 16.—Growth of yellow bass in Lake Chautauqua and in certain other waters of the United States. The graph was based on references included in text and on Table 28.

April and May. The growth rates of the yellow bass at Lake Chautauqua were excellent compared with growth rates of the species reported elsewhere (Table 28; Fig. 16; Carlander, Lewis, Ruhr, & Cleary 1953:97; Lewis & Carlander 1948:191; Ricker & Lagler 1942:94; Schoffman 1940:40 and 1958:102; and Stroud 1947:82). At Lake Chautauqua, the growth rates of yellow bass continued to be good throughout life; however, most of the yellow bass did not live beyond 5 years and none lived more than 7 years. Anglers at Lake Chautauqua who fished for yellow bass were dependent largely upon 2-, 3-, 4-, and 5-year-old fish. Only slight variations occurred from year to year in the growth patterns of the fish (Table 29).

Age Composition of Catch

The preceding section demonstrated that growth rates in most of the common and abundant fish species in Lake Chautauqua compared favorably with growth rates of these species in other waters and that in a few species the growth rates were excellent. Lack of stunted fish or slow growth of the fishes studied indicated that the fish populations of Lake Chautauqua were not overcrowded during the years of our in-

vestigation. However, the aging studies revealed that in some species the population was dominated for several years by one or two year-classes.

The present section is largely concerned with the age composition of the catch of nine species of fishes and the fluctuations that occurred from year to year in their age composition. In some instances it was possible to trace a year-class of a species in the commercial or sport fishery back to its occurrence as young-of-the-year in the minnow seine hauls. We made minnow seine hauls each summer in the period 1950-1959 in an attempt to determine spawning success of various species. A summary of these seine hauls for seven important species is given in Table 30. In 1951 and 1954, only limited numbers of hauls were made.

FRESHWATER DRUM: AGE COMPOSITION OF CATCH.—Each year in the period 1951-1958, the age composition of the commercial seine hauls of drum at Lake Chautauqua was determined. The data are presented graphically in Fig. 17, which indicates that the bulk of the catch was composed of 3-, 4-, and 5-year-old fish. We believe that the commercial seine haul collections were fairly accurate samples of the popula-

Table 30.—Number of young-of-the-year of certain fishes caught in minnow seine hauls during the summer months at Lake Chautauqua, 1950-1959.

Year and Number of Hauls	Freshwater Drum		Bigmouth Buffalo		Carp	
	Number Caught	Number Per Haul	Number Caught	Number Per Haul	Number Caught	Number Per Haul
1950 (24)	6	0.3	0	...	6	0.3
1951 (5)	2	0.4	0	...	0	
1952 (10)	18	1.8	0	...	0	
1953 (11)	0	..	118	10.7	6,629	602.6
1954 (4)	4	1.0	0	...	7	1.8
1955 (10)	3	0.3	0	...	6	0.6
1956 (13)	46	3.5	4	0.3	32	2.5
1957 (26)	3	0.1	0	...	2	0.1
1958 (34)	25	0.7	1	°	5	0.1
1959 (59)	0	..	20	0.3	56	0.9

°Less than 0.01 fish per haul.

tions of 4-year-old and older drum present each year. The 1950 and 1954 year-classes formed important constituents of the commercial catch of drum (1950 year-class shown as 4-year-olds in 1953, 5-year-olds in 1954, and 6-year-olds in 1955; 1954 year-class shown as 3-year-olds in 1956, 4-year-olds in 1957, and 5-year-olds in 1958). No large year-class appeared in the minnow seine collections (Table 30). Fish of the 1953 year-class were not taken as young in the minnow seine collections, and in the fall of 1956 this year-class as 4-year-old fish represented only a very small part of the drum population, as shown in Fig. 17. In 1959, no young-of-the-year drum were taken in 59 minnow seine collections. The later effect on the commercial fishery resulting from the apparent spawning failure in 1959 was not determined.

Very few drum over 6 years of age were taken from the lake in our study period (Table 22). Only seven drum in our collections were determined to be over 8 years of age. Even in 1951, at the beginning of our seining program, fish over 6 years of age were scarce in the seine haul collections. Apparently very few drum in Lake Chautauqua lived more than 8 years. The oldest drum taken at this lake, as shown in Table 22, was 14 years of age. Van Oosten (1938:

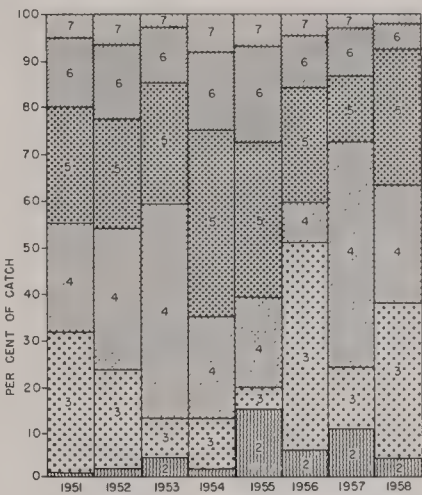


Fig. 17.—Age composition of freshwater drum in the commercial seine hauls at Lake Chautauqua, September, 1951–1958. The portions of the graph representing 7-year-old fish also included those fish that were over 7 years of age.

654) found only two drum in his collections from Lake Erie that were more than 8 years of age. One of his fish was in its 13th year, and the other was at least 17 years of age. The oldest drum that Butler & Smith (1950:46) aged in their study of fish taken from the Upper Mississippi River was 11 years old. They had only 10 drum in their collections from the Mississippi River that were over 8 years of age. Schoffman

Table 30.—Continued

Year and Number of Hauls	Gizzard Shad		Bluegill		Crappies		Yellow Bass	
	Number Caught	Number Per Haul	Number Caught	Number Per Haul	Number Caught	Number Per Haul	Number Caught	Number Per Haul
1950 (24)	87	3.6	279	11.6	86	3.6	298	12.4
1951 (5)	150	30.0	1	0.2	8	1.6	2	0.4
1952 (10)	92	9.2	304	30.4	19	1.9	6	0.6
1953 (11)	621	56.5	106	9.6	0	..	29	2.6
1954 (4)	2,000	500.0	17	4.3	16	4.0	0	...
1955 (10)	58	5.8	2,534	253.4	34	3.4	24	2.4
1956 (13)	280	21.5	211	16.2	66	5.1	18	1.4
1957 (26)	80	3.1	879	33.8	52	2.0	369	14.2
1958 (34)	71	2.1	772	22.7	23	0.7	261	7.7
1959 (59)	988	16.7	849	14.4	47	0.8	340	5.8

(1941:103) found only seven drum more than 8 years old (oldest 11 years) at Reelfoot Lake, Tennessee. Houser (1960b:4), working on drum in Oklahoma waters, found only a small per-

centage of the fish were over 8 years of age. The oldest drum in the Oklahoma study was 14 years of age.

BIGMOUTH BUFFALO: AGE COMPOSITION OF CATCH.—In our 10 years of min-

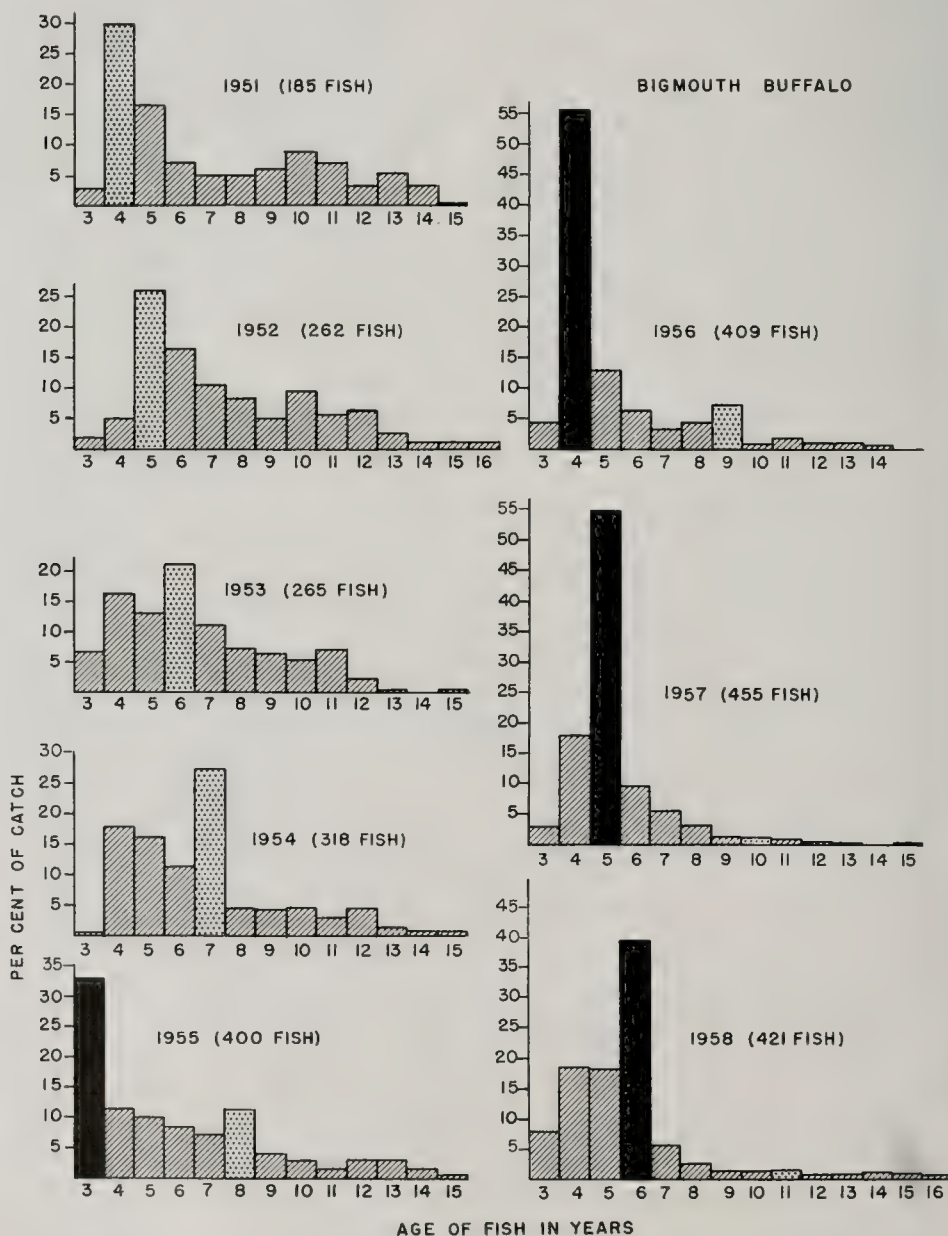


Fig. 18.—Age composition of bigmouth buffalo in the commercial seine hauls at Lake Chautauqua, September, 1951–1958. The large 1948 year-class of buffalo is represented in each of the 1951–1958 graphs by a stippled bar; fish of this year-class are shown in 1951 as 4-year-olds. The solid black bar in each of the graphs in the period 1955–1958 demonstrates the importance of the large 1953 year-class.

now seining at Lake Chautauqua (1950-1959), only one large year-class of bigmouth buffalo appeared in the hauls, that being in 1953 (Table 30). In the fall of 1955, the largest members of the 1953 year-class appeared in the commercial seine collections as 3-year-old fish (Fig. 18). The 1953 year-class is designated on the bar graphs in black. Fig. 18 shows that this year-class dominated the catch from 1955 through 1958. Earlier the buffalo fishery was dominated by the 1948 year-class. In

the fall of 1951, this large year-class (stipple on graph) appeared in the commercial seine hauls as 4-year-old fish (Fig. 18). It remained readily distinguishable from other broods in the commercial seine hauls through 1956. The annual additions of bigmouth buffalo to the adult population were insufficient to maintain a large-size population in the face of heavy fish removal. There appeared to be only a limited amount of recruitment from the Illinois River.

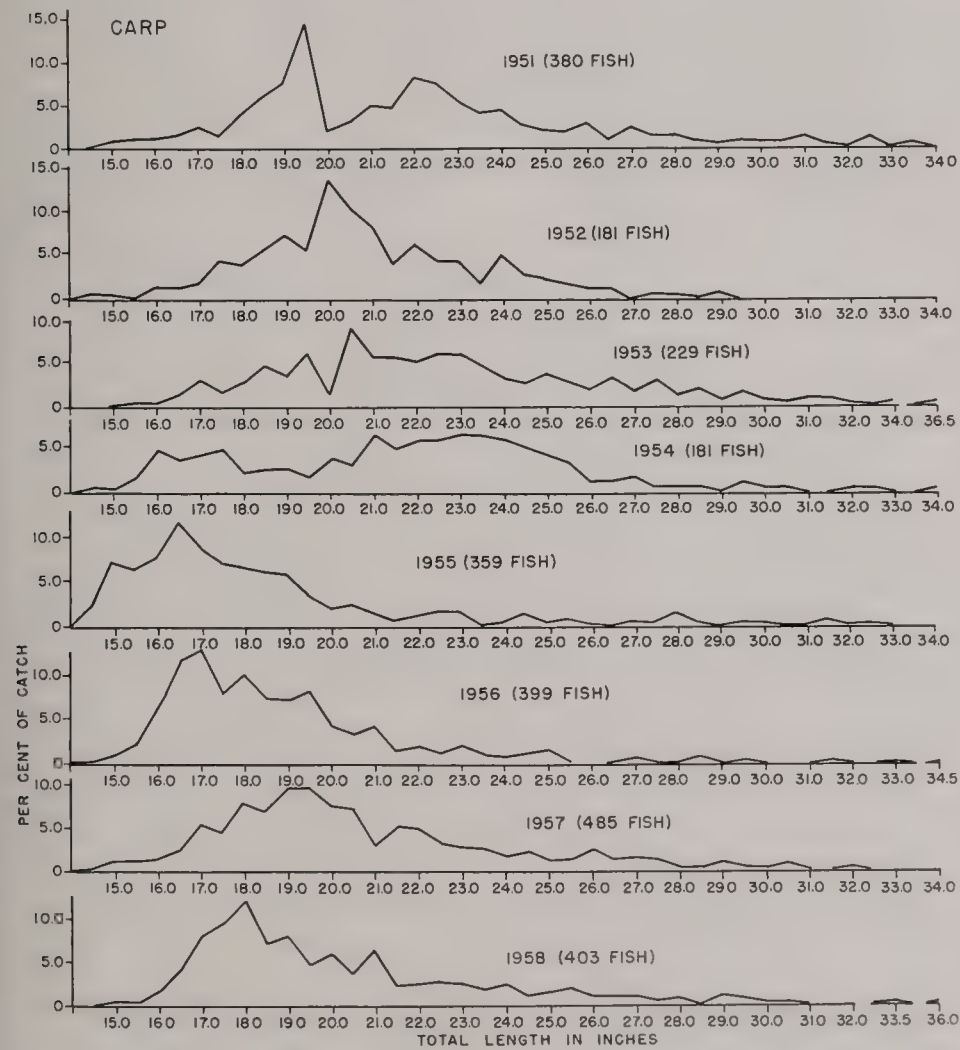


Fig. 19.—Length-frequency distribution of carp in the commercial seine hauls at Lake Chautauqua, September, 1951-1958. The graphs were based on measurements of 2,590 carp.

In the years of our investigation, only two dominant year-classes of bigmouth buffalo appeared in the adult fishery, those of 1948 and 1953. At Spirit Lake, Iowa, O. J. Koch noted that young buffalo appeared in large numbers only about every 5 years (Sigler 1949a:210). The presence of a large adult population of fish 6 years and older at Lake Chautauqua in 1951 and 1952 indicated that, with commercial fishing of light intensity (individual wing-net fishing), broods of small to moderate size, coupled with an occasional large brood, were sufficient to maintain a population of bigmouth buffalo of desirable sizes.

The increased removal of bigmouth buffalo after 1951 (Table 5) changed the buffalo population of Lake Chau-

tauca in 4 years from one containing a high percentage of old, large fish to one of predominantly young, small fish (Fig. 18). The dominant 1953 brood appears in Fig. 18 to have been much stronger in 1956 than the 1948 brood was in 1951. Actually these broods as 4-year-old fish were of about equal strength; the comparatively smaller number of old fish in 1956 than in 1951 was responsible for the apparent difference indicated by Fig. 18.

CARP: AGE COMPOSITION OF CATCH.—Age readings indicated that most of the carp taken commercially in the seine hauls at Lake Chautauqua in 1957 and 1958 were 4-, 5-, and 6-year-old fish. The carp taken commercially in the early years of our study were of larger sizes than those taken in 1957 and 1958

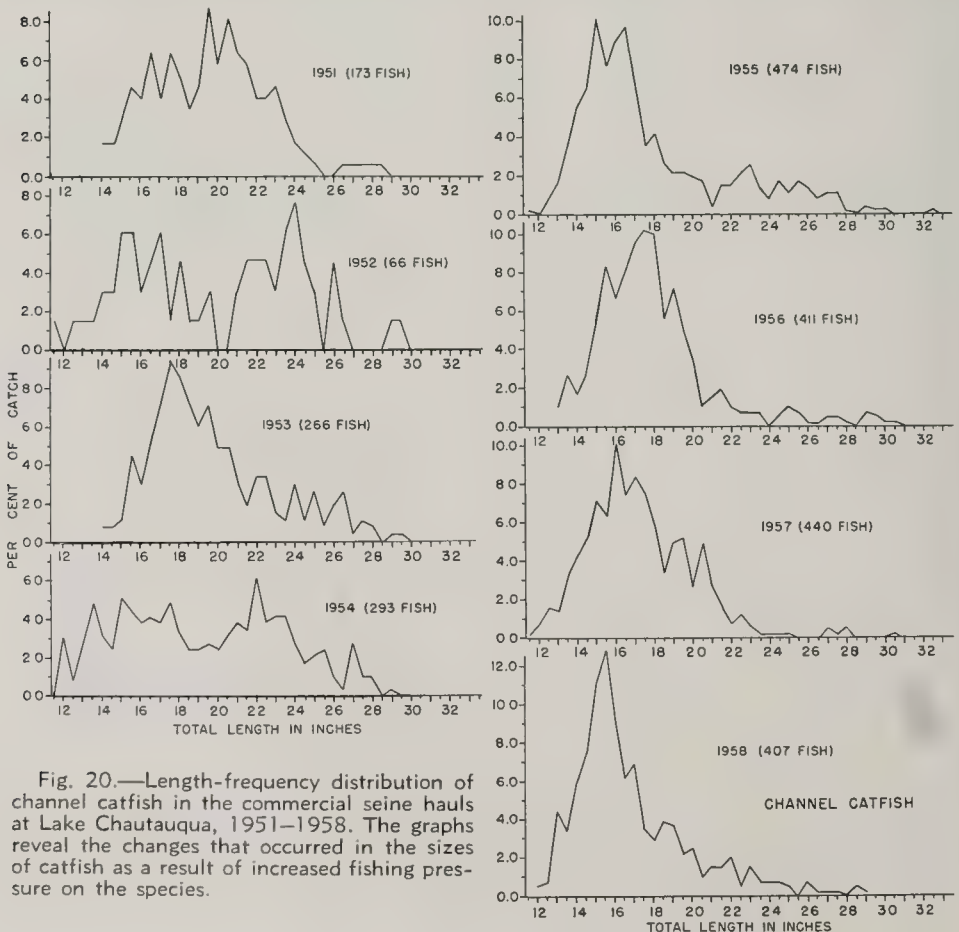


Fig. 20.—Length-frequency distribution of channel catfish in the commercial seine hauls at Lake Chautauqua, 1951–1958. The graphs reveal the changes that occurred in the sizes of catfish as a result of increased fishing pressure on the species.

(Fig. 19) and were probably older fish. A great abundance of young carp in the minnow seine hauls of 1953 indicated a tremendous spawn in that year (Table 30). The 1953 year-class of carp began to be taken as usable-size fish (approximately 15 inches and longer) in the commercial seine hauls in September of 1955. The identity of this large year-class was based on (i) the length-frequency graph (Fig. 19), which showed a high peak for the year 1955 at 16.5 inches, and (ii) the aging study (Table 25), which showed that 3-year-old carp averaged 16.1 inches in length. The 1953 brood also formed an important part of the 1956 catch but was of lesser importance in the 1957 catch. The population statistics discussed in the next section revealed that the 1953 year-class did not materialize into as large a brood of fish as was expected earlier. During the years 1955 and 1956, the population of usable-size carp was at its lowest point (Table 33 and Fig. 19). Much of the 1953 year-class was lost either through escape-ment into the Illinois River during periods of high water or through natural mortality. We believe the former was the more important cause of loss.

In 1957, both usable-size and sub-usable-size carp were abundant in the seine hauls. We believe that many carp of both of these groups were recruited from the river after September of 1956. This belief was at least partly confirmed by the presence of only small numbers of usable-size and subusable-size carp in the lake in September of 1956 (Table 33 and Fig. 19) and the small number of young carp in our minnow seine hauls after 1953 (Table 30). Carp of both sizes were quite common in the 1958 commercial seine hauls (Table 33 and Fig. 19).

CHANNEL CATFISH: AGE COMPOSITION OF CATCH.—During our study, a few young-of-the-year channel catfish were taken at Lake Chautauqua each year (other than 1954 and 1955) either in the minnow seine or rotenone collec-

tions. The small numbers taken gave no clue to the strength of any of the year-classes.

We did not begin to age channel catfish in the commercial seine haul collections until 1953. The catfish in the

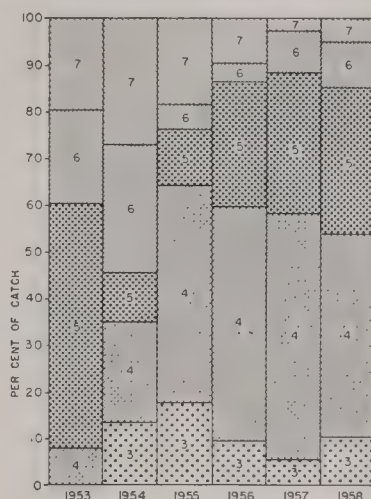


Fig. 21.—Age composition of channel catfish in the commercial seine hauls at Lake Chautauqua, 1953–1958. The bars for the years 1955–1958 show the predominance of 4-year-old fish in the catches. The portions of the graph representing 7-year-old fish also included fish over 7 years of age. Very few channel catfish more than 8 years of age were collected.

seine hauls (Fig. 20) averaged larger in the years 1951–1954 than in subsequent years. Five-year-old and older fish dominated the catfish catch in the seine hauls in 1953 and 1954 (Fig. 21). The comparatively high percentage of large fish taken in the seine hauls in 1951 and 1952 (Fig. 20) indicates that the catfish catch in those 2 years also was composed largely of 5-year-old and older fish. After 1954, the fishery was dependent largely upon 4-year-old fish (Fig. 21). The 4-year-old fish in each year did not represent a large year-class, although Fig. 21 seems to show it did. In 1958, the total catfish population was down in numbers, and the 4-year-old population in that year, even though it dominated the fishery, was small compared to the 4-year-old population in

1956. The change in the fishery from one predominantly of 5-year-old and older fish before 1955 to one of younger fish after 1954 was believed by us to have been caused by the increased commercial removal of catfish from the lake, beginning in 1954 (Table 5).

Finnell & Jenkins (1954:5) aged 7,717 channel catfish from 107 different waters in Oklahoma and reported none more than 14 years of age. They concluded that few channel catfish live

more than 7 years in Oklahoma. Our findings at Lake Chautauqua tend to corroborate the Oklahoma studies on the longevity of channel catfish. Only three of the channel catfish that we aged were more than 14 years old (Table 20). Few Lake Chautauqua catfish lived more than 7 or 8 years. Increased fishing pressure on catfish after 1953 no doubt had an effect on their survival; however, the age determinations made on the catfish caught in 1953 and 1954

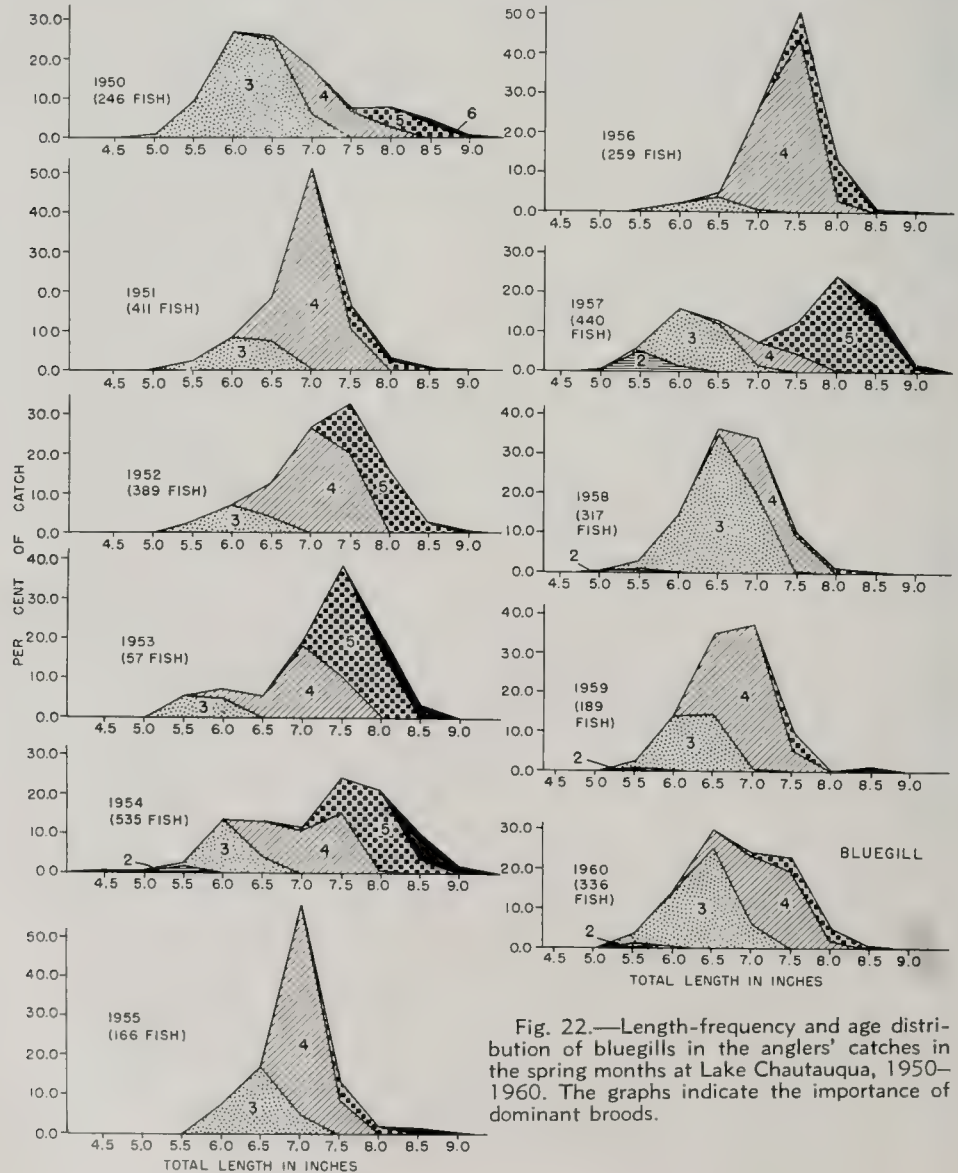


Fig. 22.—Length-frequency and age distribution of bluegills in the anglers' catches in the spring months at Lake Chautauqua, 1950-1960. The graphs indicate the importance of dominant broods.

did not indicate the presence of many fish over 8 years of age.

BLUEGILL: AGE COMPOSITION OF CATCH.—The changes that occurred in the age composition of the bluegill population of 3-year-old and older fish at Lake Chautauqua is illustrated by the anglers' catches in the spring months of 1950–1960 (Fig. 22). The graphs reveal that, in most years, the bluegill population was made up of members of several broods, of which one brood had better representation than the others. Minnow seine hauls showed that bluegills spawned with varying degrees of success in the years of our study (Table

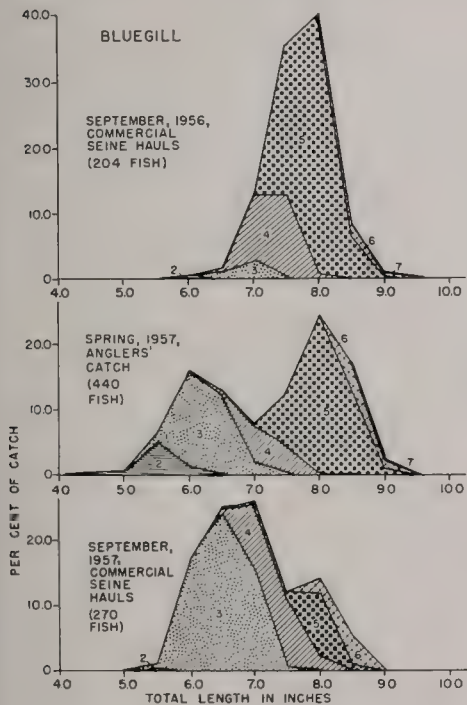


Fig. 23.—Length-frequency and age distribution of bluegills in the September, 1956 and 1957, commercial seine hauls and in the spring, 1957, anglers' catches at Lake Chautauqua. The graphs show the relative abundance of the 1952 year-class of bluegills as 5-year-olds in the September, 1956, seine collections and in the spring, 1957, anglers' catches. The September, 1957, commercial seine hauls revealed the scarcity of fish of the 1952 year-class as 6-year-olds; this scarcity indicated that high mortality of these fish as 5-year-olds occurred during the summer months of 1957.

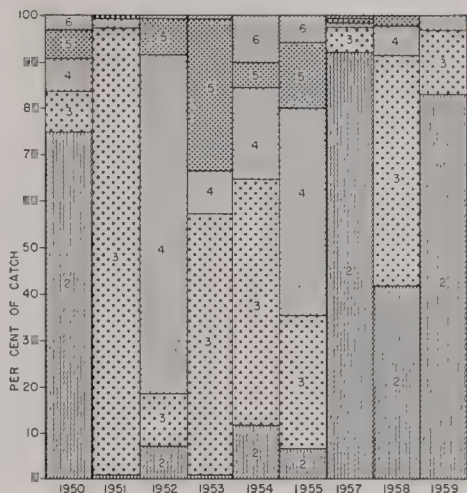


Fig. 24.—Age composition of white crappies in the anglers' catches in the spring months at Lake Chautauqua, 1950–1955 and 1957–1959. Fish of the large 1948 brood are shown as 2-year-olds in 1950.

30). The success of the several year-classes varied considerably in later life. The sport fishery was largely dependent upon 3-, 4-, and 5-year-old fish, as shown in Fig. 22.

We caught many more young-of-the-year bluegills in the minnow seine hauls in 1955 than in any other year (Table 30). Fish of the 1955 year-class appeared in large numbers as 3-year-olds in the sport fishery in the spring of 1958 and as 4-year-olds in the spring of 1959 (Fig. 22). They constituted only a minor year-class as 5-year-old fish in the spring of 1960. The strength of the 1955 year-class, in our opinion, was not as great as that of the 1952 year-class, which formed an important part of the sport fishery even as 5-year-old fish in the spring of 1957 (Fig. 22). The minnow seine hauls in 1952 indicated only a moderately successful spawn of bluegills in that year (Table 30). The minnow seine collections showed that young-of-the-year gizzard shad were more abundant in 1952 than in 1955. We suggest the possibility that, as a buffer species against predators of young bluegills, young shad served more effectively in 1952 than in 1955.

If our suggestion has validity, then we may assume that the better survival of the 1952 year-class of bluegills can be explained by the buffer action of the larger number of shad in that year.

The anglers' catch and commercial seine haul data indicate that bluegills over 5 years of age formed only a small part of the bluegill population in Lake Chautauqua during our study (Fig. 22 and 23). Bluegills hatched in 1952

dominated the commercial seine haul catch of bluegills in September, 1956, when classified as 5-year-olds (Fig. 23). Members of the 1952 brood survived through the winter of 1956-57 in sufficient numbers, still as 5-year-olds, to provide an important part of the anglers' catch in the spring of 1957 (Fig. 22). By the fall of 1957, members of the 1952 brood, as 6-year-old fish, were quite scarce (Fig. 23). Perhaps many

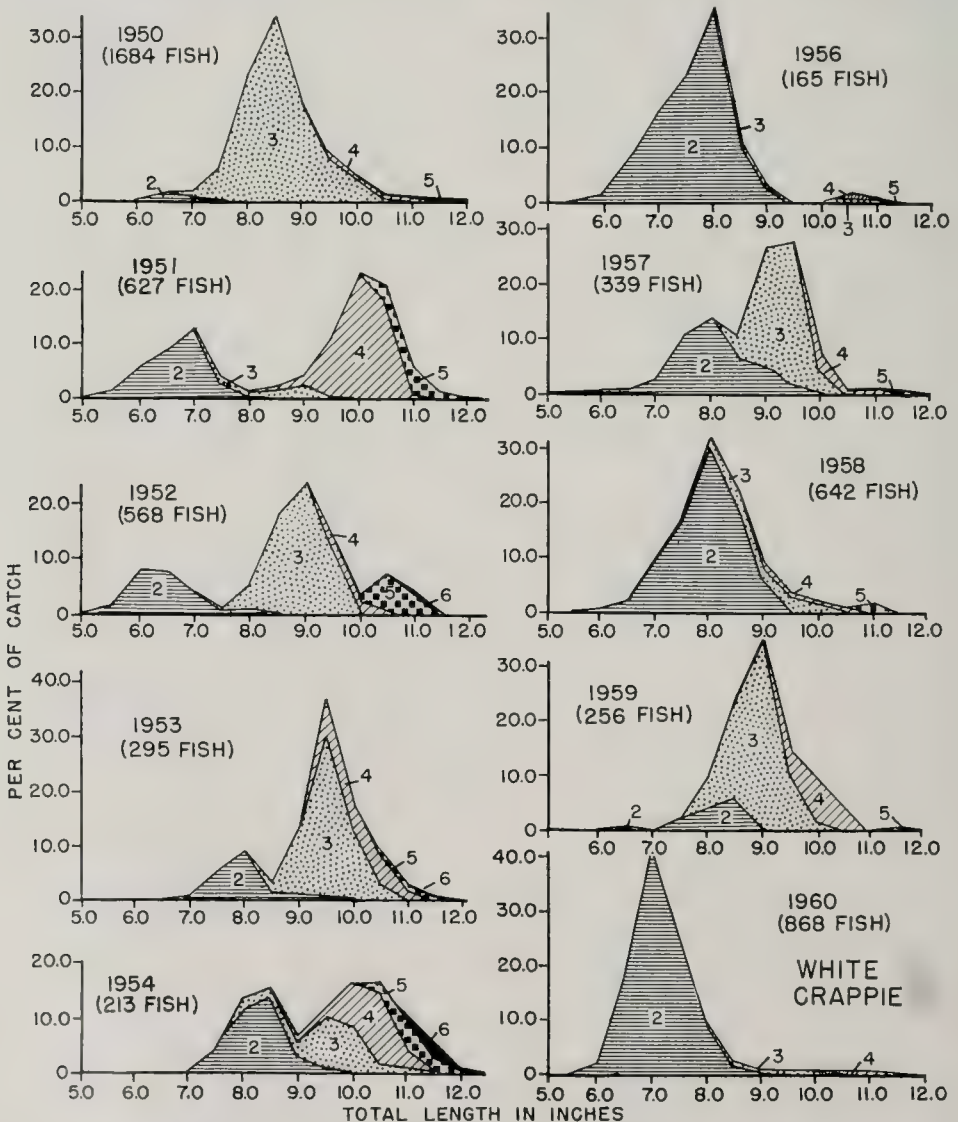


Fig. 25.—Length-frequency and age distribution of white crappies in test-net collections at Lake Chautauqua, late September and early October, 1950–1954 and 1956–1960.

members of the formerly abundant 1952 brood died from natural causes during the summer of 1957 (as 5-year-old fish). Ricker (1945:423) found that the mortality rate of bluegills at Muskellunge Lake, Indiana, was greater in summer than in winter. He stated that "it seems certain that cold-weather mortality is of an entirely different and smaller order of magnitude from that during the warm months."

WHITE CRAPPIE: AGE COMPOSITION OF CATCH.—Sport fishing for white crappies at Lake Chautauqua was largely dependent upon the presence of a large year-

class of 2-, 3-, or 4-year-old fish (Fig. 24). In the spring of 1950, 2-year-old white crappies hatched in 1948 dominated the anglers' catch. In the fall following, members of this 1948 year-class, as 3-year-old fish, formed the bulk of the catch of white crappies in the test-net collections (Fig. 25). In the spring months of 1951 and 1952, members of the 1948 year-class, as 3-year-old fish in the spring of 1951 and 4-year-old fish in the spring of 1952, dominated the anglers' catch of white crappies (Fig. 24). As 4-year-old fish, they also dominated the fall test-net collections of 1951 (Fig.

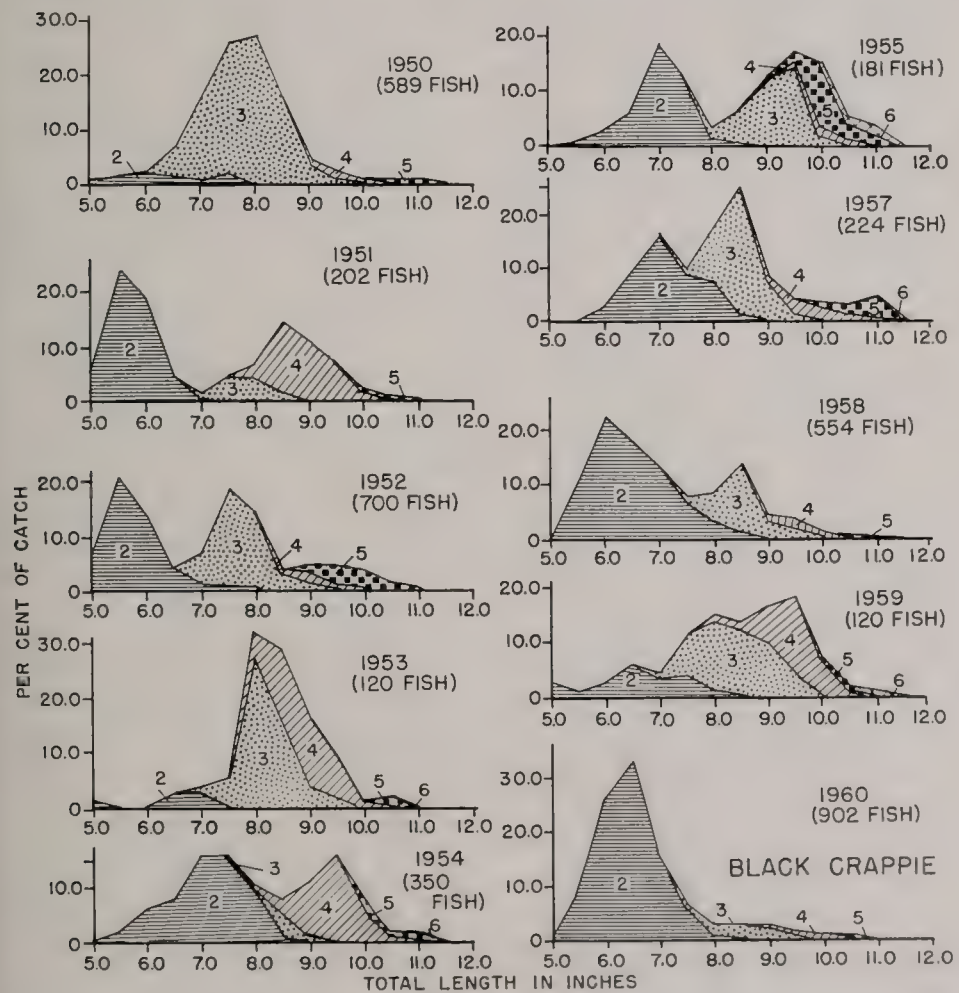


Fig. 26.—Length-frequency and age distribution of black crappies in test-net collections at Lake Chautauqua, late September and early October, 1950–1955 and 1957–1960.

25). The 1948 year-class suffered heavy natural mortality in the summers of 1952 and 1953, but its members were present in some abundance as 5-year-old fish in the anglers' catch in the spring of 1953 (Fig. 24). During the sixth summer of life, the 1948 year-class experienced heavy mortality, as evidenced by a scarcity of 6-year-old fish in the 1953 fall test-net collections. Only a few members of the large 1948 brood attained 7 years of age. The 1948 year-class was the only extremely large brood of white crappies to appear in the lake during our study.

Young-of-the-year crappies were taken in the minnow seine collections in each year except 1953 (Table 30). In no year did we catch large numbers of white crappies or black crappies in the minnow seine hauls. The survival of the different year-classes of the white crappie apparently varied, as indicated by the scarcity in some years of 2- or 3-

year-old fish (Fig. 24 and 25). The scarcity of 4- and 5-year-old fish indicated the absence of dominant broods in all but one year. Evidently, natural mortality was so high during the fourth summer of life that only a few members of a small year-class attained 4 years of age.

BLACK CRAPPIE: AGE COMPOSITION OF CATCH.—In most years of our study at Lake Chautauqua, black crappies were less abundant than white crappies. The 1948 year-class of black crappies was a dominant brood (Fig. 26) but of much smaller size than that of the white crappies. The age composition of the fall test-net collections of black crappies was in most years quite similar to those of white crappies (Fig. 25 and 26). The oldest black crappies taken during our study were 7 years of age.

YELLOW BASS: AGE COMPOSITION OF CATCH.—Young-of-the-year yellow bass were collected from Lake Chautauqua

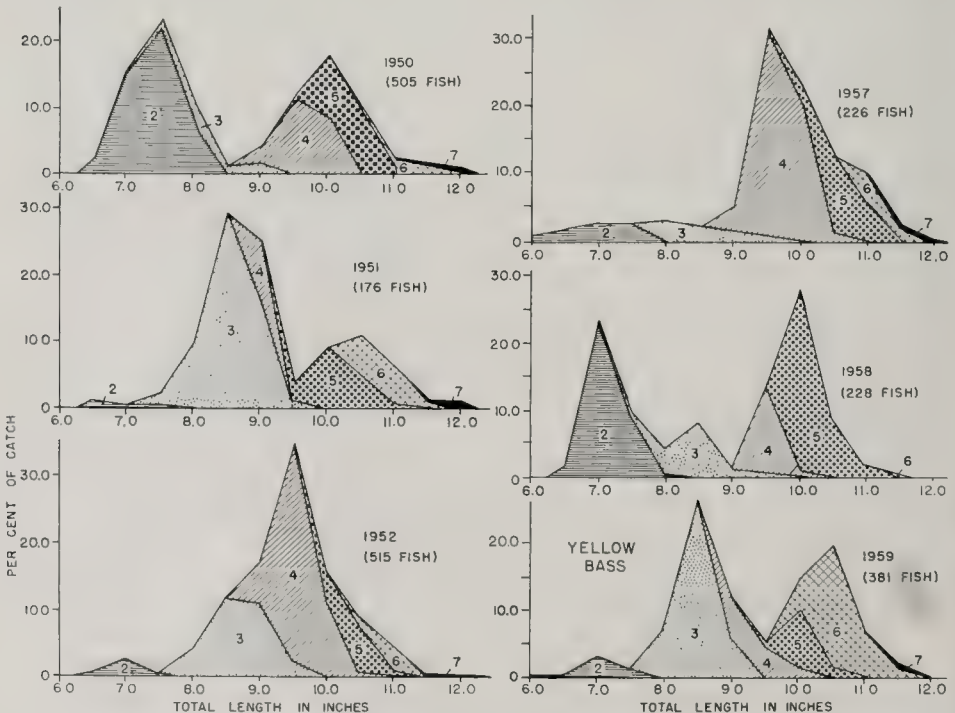


Fig. 27.—Length-frequency and age composition of yellow bass taken by anglers during the spring months at Lake Chautauqua, 1950–1952 and 1957–1959. The graphs reflect the fluctuations that occurred among year-classes in the yellow bass population.

in each summer during our investigation except that of 1954 (Table 30). The strength of the year-classes varied considerably (Fig. 27). Bailey & Harrison (1945:69) noted variations in the strength of year-classes of yellow bass at Clear Lake, Iowa.

We believe that our data on the anglers' spring catch at Lake Chautauqua gave a fair representation of the age composition of the population of yellow bass of 2 years and older. Fig. 27, pertaining to the spring months of 1950-1952, indicates that a fairly large year-class spawned in 1948. Members of this year-class appeared as 2-year-old fish in 1950 (Fig. 27). Our creel data (lengths, weights, and scales) on yellow bass in the years 1953-1955 were too meager to reflect the fate of the 1948 brood after the fourth year. In 1953, another large spawn of yellow bass was produced. The graph for the spring of 1957 shows the relative strength of the 1953 brood as 4-year-old fish (Fig. 27). Members of the 1953 brood appear as 5-year-olds on the 1958 graph and as 6-year-olds on the 1959 graph. A few yellow bass were found to have attained 7 years of age.

WHITE BASS: AGE COMPOSITION OF CATCH.—Spawning success of white bass in Lake Chautauqua was quite sporadic in the years of our study. Young white bass (1.5-3.0 inches total length) were collected in small numbers from the lake in the summer months of 1950, 1951, 1952, 1954, and 1959. Only the 1950 and 1954 year-classes appeared in subsequent years as broods of even moderate size. Our tagging studies indicated that a large percentage of the white bass over 1 year old moved out of the lake in periods of high water. Length-frequency distribution graphs of white bass in the commercial seine hauls of September, 1951, 1952, and 1956 are presented in Fig. 28. In some years, white bass (10.0 inches or more total length) were too scarce in the commercial seine hauls to provide enough specimens to make a length-fre-

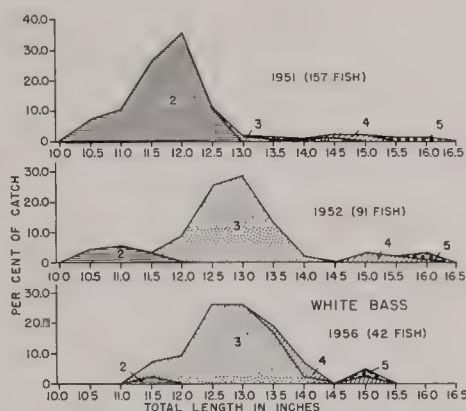


Fig. 28.—Length-frequency and age distribution of white bass in commercial seine hauls at Lake Chautauqua during the month of September in 1951, 1952, and 1956. The graphs reveal that the white bass population was dominated by single year-classes.

quency study. The length-frequency graphs for the years 1951 and 1952 reflect the strength of the 1950 year-class and the scarcity of fish of other year-classes. In 1956, the white bass population was dominated by a single year-class, that of 1954 (Fig. 28).

POPULATION DYNAMICS

The flow or dynamics of a fish population is quite complex and difficult to follow. Certain data presented in preceding sections show that the age composition of the most abundant species did not remain constant but varied from year to year. They indicate that, likewise, the spawning success and survival of year-classes of these species varied. This section is chiefly concerned with the various aspects of population dynamics dealing with the year-to-year changes in the sizes of populations of the most abundant species.

Sampling Techniques

The optimum time of sampling, the proper sampling techniques, and the number of samples required to obtain adequate population data had to be determined for our study.

At the beginning of our study, available data on the water levels of Lake

Chautauqua and the Illinois River were reviewed. We wanted a sampling period during which the Illinois River would not be connected with Lake Chautauqua—a period in which sampling could be done each year in water of approximately the same depth. Recruitment of fish from the river and escapement of fish from the lake to the river would be eliminated during a sampling period having low water levels. October or November could not be used for a large sampling program because federal regulations designed for the protection of waterfowl restricted activity on the lake during these months. September was selected as the best month for our sampling program. It appeared to provide low and relatively stable water levels and weather that was warm and otherwise favorable for sampling activities. It allowed us to collect scales and spine samples from fish after much of the growth for the year had been completed.

At one time, we considered a plan for sampling the fish populations of the lake by using rotenone to poison the fish in a series of 1-acre plots. We discarded the plan for the following reasons: (i) the number of samples needed to determine population sizes and trends was too large for the limited time and manpower available; (ii) poisoning large numbers of fish would have damaged our relations with fishermen; (iii) the number of fish killed would have been great enough to invalidate our attempts to determine the effects of commercial fishing on the fish populations.

Because of limited time and personnel, an extensive tagging and recovery program was not feasible. However, a few tagging studies designed to give population estimates of crappies, bluegills, and white bass were attempted. The number of bluegills tagged and recovered was too small to be included in our findings.

Creel censuses, test-netting, minnow seine hauls, and to a very limited extent

rotenone sampling were used in the population analysis wherever applicable.

The controlled commercial seining that was originally included as part of the program for increasing the removal of fish from the lake appeared to be the best method available for obtaining population statistics on the abundant large fish in the lake.

COMMERCIAL SEINING AS A SAMPLING TECHNIQUE.—Moody (1954:163-164) considered the drag or haul seine as the most efficient device for sampling fish populations in large, shallow Florida lakes with relatively level bottoms. He pointed out certain limitations of the seine in sampling: (i) it does not give adequate quantitative samples of those species of fish that are limited in their distribution mainly to the peripheral areas of a lake and (ii), if the sampling is not carried out over a protracted period of time, the catches may be unduly influenced by dispersal or schooling of fish.

The second limitation mentioned by Moody was not overcome in our study of Lake Chautauqua, as the seining was restricted to a single month in each year (September).

The first limitation was possibly of less consequence at Lake Chautauqua than in the Florida lakes studied by Moody (1954:150-158). The Florida lakes had depths that ranged from 3 to 12 feet. Lake Chautauqua had a relatively even depth of 2 to 3 feet. Most or all of the Florida lakes had peripheral or shoreline vegetation that undoubtedly interfered with seining. The lowering of the water of Lake Chautauqua earlier in the season to its level at the time of our seining greatly reduced the acreage of shoreline that could not be fished effectively with seines. The level of the water in September left exposed to the air some of the tree, shrub, and stumpy areas that at higher water levels were part of the lake; in parts of the stumpy areas remaining in the lake the water was too shallow for fish.

Much of the lake as it was in September was seined. The principal large areas that could not be seined were a stumpy area at the upper end of the lake and a narrow portion of the bluff-side where the area was restricted to sport fishing.

Our selection of the month of September for sampling proved to be a good one. It gave maximum uniformity in sampling, as we had constant and low water levels each year, 1951-1958. The shortness of the sampling period kept to a small number the fish that, during the period, grew to a size that could be taken in a seine haul (recruitment from within the lake).

Several variables in our seining operations lessened the value of some of our population data. For example, in 1953, heavy stands of vegetation reduced the efficiency of the seines in some areas. Temporary refuge regulations (for 1953 only) designed to protect the vegetation and make it available to ducks later in the year prohibited seining in other areas. Because of the unusual conditions in 1953, most of the data collected in that year were not comparable to the data collected in other years and were considered of little value for reflecting the population trends of fish.

In the first year of seining (1951), we restricted the number of seine hauls to allow the senior author to closely supervise the operations. Close supervision proved to be unnecessary, and the number of seine hauls made in each of the succeeding years was considerably greater than in 1951 (Table 4). In the 8 years of the seining program, 11 different crews operated seines in the lake; however, only 3 to 6 crews operated in any one season.

Individual crews varied from year to year in the size of their catches. For example, as the scatter diagram in Fig. 29 indicates, seine crew No. 1 had a poor catch in 1956, an excellent catch in 1957, and a mediocre or poor catch in 1958. Buffalo-fishes (nearly all bigmouth

buffalo) were the fish most sought after by the seine crews and, for that reason, in constructing our diagram we used only the catch data for these fish. Evidently year-to-year variations in catch

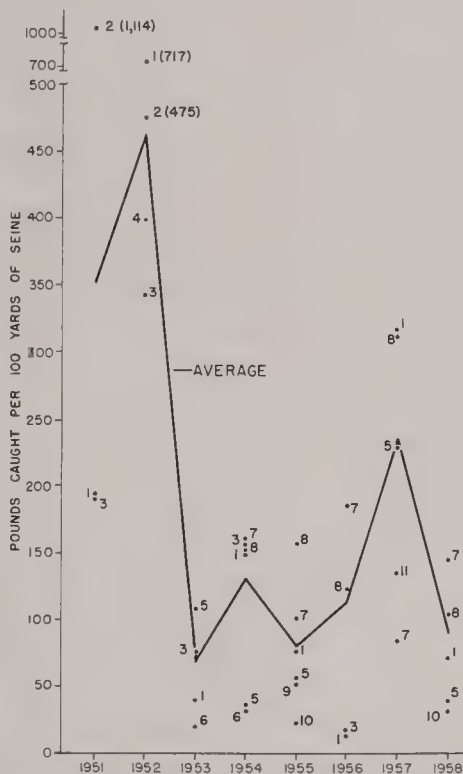


Fig. 29.—Annual catches of buffalo by 11 different commercial seine crews at Lake Chautauqua, 1951-1958. Each dot with a numeral beside it indicates the average number of pounds of buffalo caught per 100 yards of seine employed by a given crew (indicated by numeral) in a given year. Graph is based on data from 348 completed seine hauls.

by seine crews are to be expected. Data from all of the 348 completed seine hauls are included in our analysis, even though variations among hauls were so great that we suspected we had some poor samples.

The variations in catch from haul to haul were evidently a result of several factors: (i) uneven distribution or concentration of fishes in the lake, (ii) movement of fishes within the lake, and (iii) accidental loss of fish from the

Table 31.—Data on carp, buffalofishes, freshwater drum, and channel catfish caught with commercial seines in the three component parts of Lake Chautauqua (Fig. 5) in September of 1954 and 1957. The river-side fish included only those taken in seine hauls landed near the levee along the river. The bluff-side fish included those taken in the middle of the lake as well as those taken in the area near (but not adjacent to) the bluff-side shore. A narrow portion of the bluff-side water was restricted to sport fishing. Most of the bluff-side fish were taken in the middle of the lake. Figures in italics represent range.

Year and Kind of Fish	Pounds of Fish Per 100 Yards of Seine					Analysis of Variance		t Value and Degrees of Freedom			
	Lower Lake		River-Side		Bluff-Side	F Value	Degrees of Freedom		Lower Lake and River-Side	Lower Lake and Bluff-Side	River-Side and Bluff-Side
	Mean and Range	Standard Deviation	Mean and Range	Standard Deviation	Mean and Range		Standard Deviation	n ₁				n_{2}
1954	(8)°		(30)°		(19)°						
Carp	12.5 0-52	16.6	184.8 0-1534	337.5	4.4 0-38	3.68†	2	54	2.78† (15)	1.29 (11)	..
Buffalofishes	147.9 16-349	125.6	135.7 3-528	150.4	99.3 0-463	0.55	2	54	..	..	..
Freshwater drum	130.6 19-386	123.2	85.6 2-550	118.3	145.4 3-475	1.32	2	54	..	..	..
Channel catfish	27.3 3-75	23.1	27.5 1-133	33.8	20.3 1-148	0.31	2	54	..	..	..
1957	(6)°		(14)°		(23)°						
Carp	84.0 12-250	94.3	311.7 13-986	299.0	48.1 0-344	9.33†	2	40	2.57† (8)	0.86 (11)	3.23† (17)
Buffalofishes	306.5 20-963	341.0	171.9 7-498	155.5	218.7 26-538	1.01	2	40	..	..	..
Freshwater drum	55.7 1-122	49.3	48.6 0-157	45.1	101.7 0-298	2.59	2	40	..	..	..
Channel catfish	35.7 11-51	14.4	20.1 2-43	12.2	16.5 0-60	4.31†	2	40	2.33† (8)	..	0.78 (17)

*Number of seine hauls made in designated section of lake.

†Significant difference in catch at 0.05 level for degrees of freedom indicated.

Table 32.—Number of seine hauls required to detect various percentage changes in the populations of carp, buffalofishes, freshwater drum, and channel catfish at Lake Chautauqua in September of 1954 and 1957.*

Year and Kind of Fish	Number of Hauls Actually Made	Number of Hauls Required to Detect a Population Change of the Percentage Indicated					
		10 Per Cent	40 Per Cent	50 Per Cent	80 Per Cent	90 Per Cent	100 Per Cent
1954	57						
Carp		5,100	318	..	80	63	51
Buffalofishes		868	54		..	..	..
Freshwater drum		1,060	66	42	..	..	..
Channel catfish		1,252	78	50	..	..	..
1957	43						
Carp		1,866	117	75	29	..	..
Buffalofishes		630	39		..	..	..
Freshwater drum		738	46	30	..	..	..
Channel catfish		438	27	..	..	..	..

*Analysis based on formula used by Paloumpis (1958:585).

seines. The uneven distribution or concentration of fishes in the lake was thought by us to have been the most important cause of catch variations. Throughout the period of the program, the location of each seine haul was recorded. A simple analysis of the data clearly demonstrated the large variations in the catch between replicate hauls as well as between hauls at different localities in the lake. Detailed analyses were made of the seine haul data collected in 1954 and 1957. These years were selected because of their large aggregate catches (Table 5) and the 3-year interval between the two seining periods. Results of these analyses are given in Tables 31 and 32. In Table 31, the catch data for the carp, buffalofishes, freshwater drum, and channel catfish of commercial or usable sizes were separated into three groups based upon the three sections of the lake (Fig. 5) where the catches were made: (i) river-side (seine landed near levee); (ii) bluff-side (near bluff-side and middle of lake); and (iii) lower lake (from shore adjacent to Quiver Lake levee to about one-half mile into the lake). The ranges and standard devia-

tions of the catches (Table 31) showed that tremendous variations occurred among the hauls made in a given section of the lake. Because of the variations within sections of the lake, the apparently large differences between the mean values for a species in any two sections of the lake usually were found to be insignificant (Table 31). Carp appear from inspection of the mean values given in Table 31 to have occurred much more abundantly in the river-side section of the lake than elsewhere in 1954 and 1957; the differences are statistically significant. The concentration of carp in this area was observed in our first year of seining (1951). We endeavored after 1951 to seine with approximately equal intensity in all available parts of the lake in order to keep to a minimum the sampling bias caused by fish concentrations in areas favored by the various species. It appeared from our field observations that catfish occurred more abundantly in the lower lake and river-side sections than in the bluff-side section. Analysis of the catfish data do not completely substantiate these observations, since no statistically significant differ-

ences existed among the sections in 1954 (Table 31). However, in 1957 the catch of catfish in the lower lake was significantly greater than the catches in the other sections.

The analysis in Table 31 indicates that no significant differences existed among the mean values for the catches of buffalofishes and drum in the three parts of the lake seined. The catches of these species varied considerably between hauls within a section. Gizzard shad had a distribution similar to the distributions of buffalofishes and drum.

Since so much variation occurred among hauls, we wished to determine the number of hauls required per seining period to detect population changes from year to year. In making our analysis for detecting population changes, we assumed that within 30 days (month of September) very few fish were added to the commercial fishery through growth of fish, and we knew there was no recruitment of fish from the river or escapement of fish to the river during the seining period. The analysis, as we had anticipated, indicated that impractical numbers of seine hauls (438 or more) in 1 month were required to detect a 10 per cent change in the populations of the most numerous fish species (Table 32). Sufficient numbers of hauls were made to detect 40 to 50 per cent changes in the populations of buffalofishes, drum, and channel catfish. The analysis indicated that the data for carp, which were concentrated in one section of the lake, were of little value in detecting other than more drastic population changes.

The carp and bigmouth buffalo of less than commercial sizes taken in the seine hauls were returned to the lake. Sight estimates were made of the occurrence of these subusable-size fish in the seine hauls, and some length and weight data on them were collected.

We were interested in making standing crop estimates of the large abundant fishes from the seine haul data. In making these estimates we needed first

to discover a method for determining the area covered by the seines in a seining period so that the catch data could be converted to pounds of fish caught per acre. The pounds of fish caught per acre could then be referred to as a crude estimate of standing crop.

Commercial fishermen at Lake Chautauqua used three basic methods for laying out their seines, each seine usually about 800 to 1,000 yards in length. An important device employed in all three methods was a backstop, a wire mesh fence usually 30 to 50 feet long, tall enough to extend about 4 feet above the water, and held in place with stakes driven into the lake bottom. In the first method, one end of the seine was attached to one end of the backstop, the seine was laid out in the form of an approximate circle, and the other end of the seine was brought to the other end of the backstop. In the second method, the seine was laid out in the form of a trapezoid, with one side of the trapezoid parallel with the backstop and with approximately 100 yards of open water between each end of the backstop and the nearest end of the seine; the open areas were closed soon after the fishermen started hauling in the seine. In the third method, a section of seine 100 or more yards in length was attached to one end of the backstop, extended in line with the backstop, and staked. The seine proper was secured at one end to the free end of the backstop and laid out so that with the backstop and section of staked seine it formed an open end or partial D, with open water between the free end of the seine proper and the staked seine. Finally, the free end of the seine proper was dragged across the open water to the nearer end of the staked seine.

We calculated the areas covered in various seine hauls made by each of the three methods outlined above. The areas were of various shapes, but most of them were roughly circular. We found that close approximations of the actual areas covered in the seine hauls

could be made if we considered the seines as the circumferences of circles. The methods we used in estimating the area covered in an average seine haul and in estimating our catch of various species per acre are shown below. The figures are for 1954, in which the cumulative length of seine used in the total number of hauls was 49,650 yards.

- 1) To estimate the number of linear yards or feet of seine in average haul when 49,650 yards=cumulative length of seines used in 1954 and 57=number of seine hauls made in that year:

$$\frac{49,650}{57}=871.1$$

number of yards (2,613.3 feet) of seine in average haul

- 2) To estimate the number of square feet covered in average seine haul (2,613.3 feet, the length of seine in average haul, is assumed to be equal to the circumference, C, of the roughly circular area covered in a haul):

$$a) \text{ Diameter } (d)=\frac{C}{\pi};$$

$$\text{radius } (r)=\frac{d}{2}; \pi=3.14$$

$$d=\frac{2,613.3}{3.14}=832.3$$

diameter of area in feet

$$r=\frac{832.3}{2}=416.2$$

radius of area in feet

$$b) \text{ Area } (A)=\frac{Cr}{2} \text{ (or } \pi r^2)$$

$$\frac{2,613.3 \times 416.2}{2}=543,827.8$$

number of square feet covered in average seine haul

- 3) To estimate the number of acres (43,560 square feet in 1 acre) covered in average seine haul:

$$\frac{543,827.8}{43,560}=12.5$$

number of acres covered in average seine haul

- 4) To estimate the number of acres covered in the 1954 seine haul program (57 seine hauls):

$$12.5 \times 57=712.5$$

number of acres covered in 1954 seine haul program

- 5) To estimate the catch of buffalo per acre seined when 65,489=pounds in catch and 712.5=acres seined:

$$\frac{65,489}{712.5}=91.9 \text{ (or 92)}$$

number of pounds per acre

The estimated catches per acre of usable-size fish of the most important species seined from Lake Chautauqua in 1954 were as follows:

buffalo (15 inches or longer), 65,489 pounds or 92 pounds per acre
drum (10 inches or longer), 61,163 pounds or 86 pounds per acre
channel catfish (13 inches or longer), 13,038 pounds or 18 pounds per acre

carp (15 inches or longer), 49,139 pounds or 69 pounds per acre
gizzard shad (9.5 inches or longer), 33,755 pounds or 47 pounds per acre

In spite of the limitations of the drag or haul seine for determining population trends, we believe that, if about 40 or more hauls were made in a short period of low water levels in a body of water the size of Lake Chautauqua, any major change (40 or 50 per cent) in a population of catchable-size fishes of species other than carp could be detected.

TAGGING AND TEST-NETTING AS SAMPLING TECHNIQUES.—The tagging and recovery of individual fish as a means of estimating the total population of fish in an enclosed body of water has been widely adopted since C. G. J. Petersen

discussed the technique in 1896 (Ricker 1958:81).

Although in our Lake Chautauqua studies we tagged and released crappies (both species) and bluegills in 1950-1954 and white bass in 1951-1954, the number of tagged fish recovered was so small that, in estimating populations or standing crops, we were able to use only the data on crappies tagged in 1950 and 1951. We estimated the standing crops of crappies in the fall months of 1950 and 1951 by using Chapman's variation of the Petersen method (Ricker 1958:85), which was based on the number of marked and unmarked fish caught in a given period of time. The procedure we used in 1950 was similar to that described below for 1951.

In October, 1951, the Natural History Survey test-netting crew caught, tagged, and released 547 adult crappies (both species). From October, 1951, through April, 1952, anglers and commercial fishermen removed 21,514 adult crappies from the lake. During that period, 41 tagged fish were recaptured. Crappies caught by anglers were checked for tags by boat liverymen, and those caught by commercial fishermen were checked by Natural History Survey personnel. The computations made in determining the size of the standing crop of the 1951 fall crappie population are shown below. Not considered in the computations was (i) the possibility that the mortality rate of tagged fish might be higher or lower than that of the other fish or (ii) the possibility of recruitment from and loss of fish to the Illinois River. As no tagged white crappie was recovered from the river, we assume that few if any fish of this species were lost to the river.

$$N = \frac{(M + 1)(C + 1)}{R + 1}$$

where

N = Number of fish in population at time of marking

M = number of fish marked

C = number of fish caught

R = number of tagged fish recaptured

$$1) \frac{(547 + 1)(21,514 + 1)}{41 + 1} = 280,719$$

number of adult crappies in lake

0.5 pound = average weight of adult crappies

$$2) 280,719 \times 0.5 = 140,360$$

number of pounds of adult crappies in lake

3,562 = number of acres in lake

$$3) \frac{140,360}{3,562} = 39.4 \text{ or approximately } 40$$

number of pounds of adult crappies per acre

Of course, the figure 40 represents only a rough estimate.

Test-nets, fished at 11 or 12 Lake Chautauqua sites in late September and early October of each year, 1950-1959, provided catch data to be used in estimating population trends of the crappies and the gizzard shad. The data were expressed as number of fish caught per net-day. In 1953 and to a lesser extent in 1956, the heavy stands of vegetation appeared to reduce the efficiency of our nets for catching crappies. Our observations indicate that data from catches of the bluegill in our test-nets did not reflect the population trends in this species as well as did the data from the creel censuses and the commercial seine hauls.

Standing Crop

Thompson (1941:209) estimated that the fish populations in floodplain lakes of the Illinois River valley weighed "400 or 500 pounds per acre." The combined 1951 and 1952 commercial seine haul data for Lake Chautauqua indicated that fishermen removed from this lake an average of 385 pounds of commer-

cial-size buffalofishes, carp, freshwater drum, and channel catfish per acre seined (Table 33). Twenty additional pounds of shad were caught per acre seined. These calculated catch values represent a standing crop of about 405 pounds of large fish per acre. The standing crop of adult crappies in 1951 was estimated to be 40 pounds per acre. Test-netting and minnow seining indicated that, in addition to the fish mentioned above, there were probably 50 to 75 pounds of other fish per acre. The total standing crop was estimated to be about 500 pounds per acre in the 1951-1952 period. This estimate is similar to Thompson's.

The removal of fish during the program (Table 5) no doubt reduced the abundance of commercial-size buffalofishes, carp, drum, and channel catfish in Lake Chautauqua. Natural mortality, escapement from the lake to the Illinois River, and recruitment from the river to the lake no doubt contributed to changes in the composition of the fish population in the lake (Table 33). By

1955, the standing crop of the usable-size fish of the four commercial kinds mentioned above and the noncommercial gizzard shad was estimated to be only 189 pounds per acre, but the total standing crop in the lake we believed to be much larger. Our belief was substantiated by the great abundance of small buffalo and the somewhat lesser abundance of small carp that were observed in the seines in 1955 and returned to the lake. In the fall of 1957, the estimated standing crop of usable-size fish of four commercial kinds and gizzard shad was 383 pounds per acre, not far below the estimated standing crop of usable-size fish of these kinds in the 1951-1952 period (Table 33). The species composition of the populations in the two periods was different. Gizzard shad were much more abundant in 1957 than in the earlier period. Also in 1957, undersize or subusable carp were more abundant. Data in Table 37 indicate that, in 1958, much of the poundage of commercial-size gizzard shad lost through the extensive

Table 33.—Calculated poundage of usable-size buffalofishes, carp, freshwater drum, channel catfish, and gizzard shad caught per estimated acre seined at Lake Chautauqua, 1951-1952 and 1954-1958.* Because of restrictions on seining in 1953, the data for that year were not representative and were not used. Estimates were made of abundance of subusable-size buffalofishes and carp in seine hauls.

Year and Number of Hauls	Pounds of Fish Caught Per Estimated Acre Seined						Fish of Subusable Sizes	
	Buffalo- fishes	Carp	Freshwater Drum	Channel Catfish	Gizzard Shad	Total	Buffalo- fishes	Carp
1951-1952 (37)	251	70	55	9	20	405	Scarce	Scarce
1954 (57)	92	69	86	18	47	312	Scarce†	Scarce†
1955 (66)	58	16	67	13	35	189	Abundant	Common
1956 (50)	75	12	40	23	51	201	Scarce	Scarce
1957 (43)	143	85	52	14	89	383	Common	Abundant
1958 (48)	61	72	40	5	54	232	Scarce	Common

*Most of the usable-size fish of the four commercial kinds were individuals of legal lengths; most of the gizzard shad were 9.5 inches or more total length.

†Young fish were abundant in the lake, but were too small to be caught in seines.

removal of fish in 1957 was replaced by a poundage of shad of less than 9.5 inches in length, which were common in the test-nets.

Thompson's and our estimates of pounds of fish per acre in Illinois River floodplain lakes were slightly higher than estimates made by Lambou (1959:11) for lakes along the Mississippi River in Louisiana (average of 397 pounds per acre). Lambou (1959:10) found that some species—buffalofishes, white bass, and catfishes—were highly migratory in backwater habitats; they were more abundant in the lakes in periods of high water than in periods of low water. A similar situation probably prevailed at Lake Chautauqua; our observations indicated that movement of some species of fish between the river and the lake occurred during times of high water. However, we believe that certain other species did little migrating; either most individuals of these species remained in the lake during high water levels or they returned to the lake before they could be cut off from the lake by receding water. This belief was at least partly confirmed by our finding of year-to-year continuity in year-classes of certain species and by our tag returns from certain species. Data on the continuity of year-classes in certain species are given in the section of this paper entitled "Age Composition of Catch."

Population Changes

Estimates of the standing crop indicated that the carrying capacity of Lake Chautauqua at the time of our study was at least 500 pounds of fish per surface acre. The population was known to have included as many as 64 different species of fish. Considerable variation in population size of the various species occurred during the years of our study. The bulk of the population, as estimated by weight of the catch, was composed of nine species: big-mouth buffalo, carp, freshwater drum, channel catfish, gizzard shad, white

crappie, black crappie, bluegill, and yellow bass. These were considered by us as the influential species in the lake, and the variations in their abundance probably affected the entire fish population. Although other species also varied in abundance, most of them were not abundant enough to have had more than minor roles in the ecology of the lake.

FRESHWATER DRUM: POPULATION CHANGES.—The trends in the freshwater drum population at Lake Chautauqua are reflected in Table 34. Because of poor seining conditions and unusually restrictive fishing regulations in 1953, we have omitted the catches for that year from the analysis of the catch data. The means of the catches per 100 yards of seine used varied from year to year; however, these differences must be evaluated carefully because of the large variations in catch among the hauls, as discussed in the subsection "Commercial Seining as a Sampling Technique."

The analyses presented in Tables 31 and 32 indicate that in 1954 and 1957 drum were fairly well distributed among the three components of the lake and that enough hauls were made to detect at least 50 per cent population changes. The differences among drum populations in the various years of seining (populations based on catch per 100 yards of seine used) were slightly significant ($F = 2.62$, $d.f. = 5$ and 295); the difference between the drum population of 1954 and the smaller population of 1956 was slightly significant ($t = 2.57$, $d.f. = 52$). (The catch data in Table 34 show that the trend of the population of drum was downward after 1954.) The drum catch dropped to its lowest point in 1958. The decline was apparently related to the increased removal of drum in 1954 and 1955 (Table 34) and the scarcity of individuals of two year-classes in the lake in the 1956–1958 period. In 1954 and 1955, the drum fishery was largely dependent upon 4-, 5-, and 6-year-old fish (Fig. 17). By September

Table 34.—Population trends of freshwater drum at Lake Chautauqua as reflected in commercial seine hauls (made during September) and in total catch per acre of water (all fishing methods combined), 1951–1958.

Year	Number of Hauls	Pounds Caught Per Estimated Acre Seined	Pounds Caught Per 100 Yards of Seine			Total Pounds Caught and Removed Per Acre of Water
			Mean	Standard Error	Range of True Mean at 95 Per Cent Level	
1951	13	...	...		...	3.9
1952	24	54.9°	94.5°	±15.7°	62.6 to 126.4°	9.8
1953	47	†	79.7†	±15.2	49.0 to 110.4	9.7
1954	57	85.8	111.9	±17.4	77.1 to 146.7	20.6
1955	66	66.7	98.0	±14.3	69.4 to 126.6	17.7
1956	50	39.8	62.6	± 8.2	46.1 to 79.1	8.6
1957	43	52.1	78.0	±11.6	54.6 to 101.4	11.2
1958	48	40.2	57.0	± 7.5	41.9 to 72.1	8.3

°1951–1952 data were combined.
†Data for 1953 were not used because they were not considered representative; vegetation made seining difficult, and temporary regulations designed to protect waterfowl food plants prohibited seining in some areas.

of 1956, the fish of 5 years and older had evidently been reduced in numbers through fishing and natural mortality to the point where the presence of a large year-class was required to maintain a high population. In September of 1956, fish of the comparatively small 1953 year-class, as 4-year-olds, formed only a minor part of the drum catch (Fig. 17). The 1954 year-class was evidently larger than the 1953 year-class and in September, 1957, when regarded as 4 years old, it comprised an important part of the drum catch. However, the 1954 year-class was not large enough to compensate for the weak 1953 year-class, which was regarded as 5 years old in September, 1957 (Fig. 17). The lack of large year-classes in the lake accounted for the low drum population (as measured by the catch) in 1958. We doubt if there was sufficient removal of drum after 1955 to have had much effect on the size of the drum population in 1958. The population probably would have been low in 1958 even though there had been no fishing.

CHANNEL CATFISH: POPULATION CHANGES.—The catch of catfish per 100 yards of seine varied considerably from

year to year (Table 35), and certain of the differences were found to be significant ($F = 8.66$, $d.f. = 5$ and 295). The catch data show that the population increased in size after 1953 and continued to be relatively large until 1958. The difference in catch between 1957 and 1958 was found to be significant ($t = 5.48$, $d.f. = 44$).

In 1955, the percentage of large catfish (20 inches or more in length) taken in the seine hauls dropped considerably (Table 35 and Fig. 20). The decrease in percentage of large individuals in the catch that year may have been caused by heavy removal of catfish in 1954 (Tables 5 and 35). It was accompanied by an increase in number of 3- and 4-year-old fish in the catch (Fig. 21). As Fig. 21 shows, the catch each year after 1954 was largely dependent upon 4-year-old fish. The sharp decline in the catch in 1958 was caused by the small size of the 1955 brood, then classified as 4 years old, and by heavy removal in previous years of 4-year-old and older fish. The number of catfish removed from the lake each year after 1953 was estimated to have been 35 to 50 per cent of the catfish of 13.0 inches or longer in the popula-

tion (estimate based on data given in Table 35). The catfish population was no doubt affected by fishing. The fishing success that continued up to 1958 indicated that increased removal of fish may have contributed to spawning success and survival and provided space for young catfish entering the lake from the river.

During high-water periods, probably some channel catfish left the lake while others entered it. In the course of aging catfish, we noted that some of the fish had made poor growth in their early years, and we considered that such fish might have been recruited from the river. They were not very common in the collections, and we are of the opinion that a goodly percentage of the catfish that we caught were either spawned in the lake or were recruited from the river as very young fish.

Our collection of population data on catfish stopped after the 1958 season. Commercial trotline fishermen reported that the catch of legal-size catfish was "poor" in 1959, while commercial

wing-net fishermen informed us that catfish were "fairly abundant" in 1960. The catch rates of pole-and-line fishermen, 1950-1959 (Table 35), offered no clear indication of either a decline or a recovery in the catfish population during the period of our study. However, the low pole-and-line catch rate for 1958 tends to confirm other low figures for 1958 (Table 35).

The estimated standing crop of channel catfish, or estimated catch per year per acre seined, was about 17 pounds in the 1954-1957 period. In Oklahoma, Houser (1960a:12) estimated the standing crop of channel catfish in Lake Lawtonka to be 10.9 pounds per acre; he contrasted this figure with 28.0 pounds per acre, the average standing crop of catfish (all ages) in 16 Oklahoma reservoirs. Sandoz (1960:141), also in Oklahoma, estimated standing crops of channel catfish to be 16.6 pounds per acre in Laughridge Pond and 19.0 pounds per acre in Mahan Pond. The high annual yields at Lake Chautauqua of 8.3 to 9.0 pounds of

Table 35.—Population trends of channel catfish at Lake Chautauqua as reflected in pole-and-line catch, in commercial seine hauls, and in total catch per acre of water (all fishing methods combined), 1950-1959.

Commercial Seine Hauls (September)								Total Pounds Caught and Removed Per Acre of Water
Year	Pole-and- Line Catch Per Fisherman- Day (Number of Fish)	Number of Hauls	Per Cent of Catch Measuring 20.0 Inches or More Total Length	Pounds Caught Per Estimated Acre Seined	Pounds Caught Per 100 Yards of Seine			
					Mean	Standard Error	Range of True Mean at 95 Per Cent Level	
1950	0.12	..	..	..	..	..	..	4.7
1951	0.09	13	48.0	..	..	..	..	4.3
1952	0.09	24	50.0	9.1*	15.4*	±2.2*	10.9 to 19.9*	5.0
1953	0.06	47	39.1	..†	9.3	±1.9	5.5 to 13.1	3.7
1954	0.07	57	46.1	18.3	25.0	±4.2	20.8 to 29.2	8.5
1955	..	66	23.6	12.6	17.3	±1.9	13.5 to 21.1	8.3
1956	0.08	50	16.5	22.6	35.4	±5.3	24.7 to 46.1	9.0
1957	0.07	43	16.6	13.8	20.3	±2.3	15.6 to 25.0	7.7
1958	0.04	48	15.2	4.6	6.6	±1.0	4.6 to 8.6	3.7
1959	0.06	..	..	..	..	..	..	2.9

*1951-1952 data were combined.
†Data for 1953 were not used because they were not considered representative; vegetation made seining difficult, and temporary regulations designed to protect waterfowl food plants prohibited seining in some areas.

usable-size catfish per acre, 1954-1956, as shown in Table 35, tended to confirm our estimates that Lake Chautauqua contained a large catfish population.

BIGMOUTH BUFFALO: POPULATION CHANGES.—In the years of our study, the sizes of the catch of bigmouth buffalo at Lake Chautauqua changed considerably (Table 36). Some of the changes in catch per 100 yards of seine were highly significant ($F=14.15$, $d.f.=5$ and 295) and were probably caused for the most part by increased fish removals. The largest catches occurred in the years 1951-1952 combined and 1957. The difference in catch between these two periods was only slightly significant ($t=2.21$, $d.f.=39$). The population in 1951-1952 was composed mainly of members of the large 1948 year-class and a considerable number of older fish; the population in 1957 was dominated by the large 1953 year-class and contained very few older fish (Fig. 18). A scarcity of older fish in the collections after 1955 resulted from the removal of many of these fish and from natural mortality.

The drop in the catch (Table 36) from 215.7 pounds per 100 yards of

seine (142.5 pounds per acre) in 1957 to 84.3 pounds per 100 yards of seine (60.5 pounds per acre) in 1958 was rather significant ($t=4.04$, $d.f.=44$). The large 1953 year-class first suffered fishing mortality in 1955 at the age of 3 years (Fig. 18). In our opinion, in that year large numbers of the smaller members (less than 15 inches) of the 1953 year-class that were caught and released died as a result of being bagged in the seine. On one haul in 1955, the senior author saw about 20,000 pounds of these undersize fish released. No individuals of a series of undersize buffalo that were tagged were ever retaken. From time to time during the seining period, dead members of this group of small fish were seen floating in the water. In 1956 and 1957, the 1953 year-class, as well as older year-classes, suffered heavy fishing mortality. The presence of large numbers of old fish in the population in the early years of our seining program (Fig. 18) demonstrates that the bigmouth buffalo is a long-lived fish. We believe that the decline in the bigmouth buffalo population in 1958 might have been minor had there been no fishing after 1954.

Table 36.—Population trends of bigmouth buffalo at Lake Chautauqua as reflected in commercial seine hauls (made during September) and in total catch per acre of water (all fishing methods combined), 1951-1958.

Year	Number of Hauls	Per Cent of Fish Measuring 20.0 Inches or More Total Length	Pounds Caught Per Acre Seined	Pounds Caught Per 100 Yards of Seine			Total Pounds Caught and Removed Per Acre of Water
			Estimated	Mean	Standard Error	Range of True Mean at 95 Per Cent Level	
1951	13	53.5	...	...	...	...	38.4
1952	24	70.2	250.7°	444.5°	±99.1°	243.3 to 645.7°	52.5
1953	47	65.4	†	75.6	±13.0	49.3 to 101.9	46.4
1954	57	69.3	91.9	125.3	±17.7	89.9 to 160.7	52.4
1955	66	46.8	58.1	74.4	± 8.4	57.6 to 91.2	45.3
1956	50	29.3	74.8	113.4	±15.3	82.6 to 144.2	40.0
1957	43	30.2	142.5	215.7	±29.7	155.7 to 275.7	53.8
1958	48	39.8	60.5	84.3	±13.1	58.0 to 110.6	32.6

°1951-1952 data were combined.
†Data for 1953 were not used because they were not considered representative; vegetation made seining difficult, and temporary regulations designed to protect waterfowl food plants prohibited seining in some areas.

GIZZARD SHAD: POPULATION CHANGES. —Because we found that sampling methods were selective for various sizes of gizzard shad, we have included in our population analysis of this species the catch data from each of the three methods we used: minnow seining, test-netting, and commercial seining (Table 37).

Minnow seine collections indicated that a great amount of variation occurred from year to year in the spawn-

($F = 5.95$, $d.f. = 6$ and 317) existed in the number of pounds of adult shad caught per 100 yards of seine in the various years. The shad catch was significantly greater per 100 yards of seine in 1954 than in 1951 ($t = 4.02$, $d.f. = 26$). Similarly, the catch in 1957 was significantly greater than in 1954 ($t = 3.34$, $d.f. = 49$).

The fluctuations in the numerical size of the shad population (as reflected in the catch) were probably related to a

Table 37.—Population trends of gizzard shad at Lake Chautauqua as reflected by minnow seining, test-netting, and commercial seining, 1950–1959.

Year	Minnow Seine (Summer),	Test-Net (Fall),	Commercial Seine Hauls (September)				
	Number of Young Caught Per Haul	Number of Fish Caught Per Net-Day	Number of Hauls	Pounds Caught Per Estimated Acre Seined	Pounds Caught Per 100 Yards of Seine		
					Mean	Standard Error	Range of True Mean at 95 Per Cent Level
1950	3.6	2.00					
1951	30.0	2.54	13		16.8	± 1.9	12.6 to 21.0
1952	9.2	3.22	24	19.7*	†		
1953	56.5	4.21	47		27.8	± 7.1	13.5 to 42.1
1954	500.0	5.13	57	47.4	62.6	± 11.2	40.1 to 85.1
1955	5.8	3.31	66	34.7	48.3	± 7.2	33.9 to 62.7
1956	21.5	0.74	50	50.9	80.4	± 11.1	58.1 to 102.7
1957	3.1	9.59	43	88.5	129.5	± 28.6	71.7 to 187.3
1958	2.1	20.37	48	53.8	54.1	± 10.3	33.4 to 74.8
1959	16.7	2.38					

*1951–1952 data were combined.
†1952 shad catch data were not separated by individual haul and could not therefore be used in determining the mean catch.

ing success of the gizzard shad. For any one year-class, there appeared to be little or no relationship between its numbers as young-of-the-year in minnow seine collections and its numbers as adults in test-nets or commercial seines (Table 37). Both test-netting and commercial seining indicated that the adult shad population was quite small in the 1950–1952 period. In 1951–1952 combined, the catch of adult shad per estimated acre seined amounted to only 19.7 pounds; in 1957, the year in which the catch of adult shad reached its maximum, the catch was 88.5 pounds per acre. An analysis of variance of the commercial seine haul data (Table 37) indicated that significant differences

number of factors. The large adult population of bigmouth buffalo in the 1951–1952 period (Table 36) may have competed with the adult shad population. Then, as the buffalo population was reduced in size through fishing and natural mortality, the adult shad population appeared to increase and may have partially filled the niche formerly occupied by the large buffalo population. We believe that some of the adult shad in the population of Lake Chautauqua in 1957 and 1958 were recruited as adult fish from the Illinois River. Adult shad were seen entering the lake during periods of high water in 1957; we assumed these were river fish and not lake fish that were returning to the

lake after having gone out to the river. Subadult shad were scarce in the fall test-net collections in 1956 (Table 37).

Predation upon young shad by an extremely large adult crappie population that was present in the 1949-1951 period may have been partly responsible for small adult shad populations in 1951 and 1952. Jenkins (1953:53) reported a striking decrease in the young-of-the-year shad population in Grand Lake, Oklahoma, and thought the decrease might have been linked with the tremendous expansion of the white bass population in the lake. The increased removal of large channel catfish from Lake Chautauqua by commercial fishing reduced catfish predation upon adult shad after 1954 (many catfish 20.0 inches or more in length were observed to contain large shad). Winter-kill resulting from sudden changes in temperature and in carbon dioxide tensions (Miller 1960:385-386; Powers, Shields, & Hickman 1939:259) may have been an important factor influencing the abundance of adult shad in the lake.

CARP: POPULATION CHANGES.—It was pointed out earlier in this paper that the commercial seine data could be

used to detect only large changes in the carp population. Analysis of variance calculated for the catch of adult carp per 100 yards of seine used indicated that significant differences existed between the catches for various years ($F=4.42$, $d.f.=5$ and 295). The catch of adult carp in 1951-1952 combined and in 1954 was about 70 pounds per acre (Table 38). In 1957 and 1958, the catch of adult carp was a few pounds more per acre. No significant difference was detected for the carp on a catch-per-acre-seined basis between 1951 and 1952 combined and 1957 ($t=0.52$, $d.f.=39$). The catch of carp in 1955 was much lower than in 1954, and the difference was slightly significant ($t=2.20$, $d.f.=60$). The catch in 1957 was significantly higher than the catch in 1956 ($t=3.52$, $d.f.=45$). The carp catch in 1955 and 1956 appeared to be significantly lower than in other years of our study, and we have assumed that the adult population in 1955 and 1956 also was lower.

Carp taken in the seine hauls were notably smaller in 1955-1956 than in 1951-1954 (Table 38). The decrease in size was evidently related to fishing mortality or to movement of the larger

Table 38.—Population trends of carp at Lake Chautauqua as reflected in commercial seine hauls (made during September) and in total catch per acre of water (all fishing methods combined), 1951-1958.

Year	Number of Hauls	Average Weight of Fish in Pounds	Per Cent of Fish Measuring 20.0 Inches or More Total Length	Pounds Caught Per Acre Estimated Per Seined	Pounds Caught Per 100 Yards of Seine			Total Pounds Caught and Removed Per Acre of Water
					Mean	Standard Error	Range of True Mean at 95 Per Cent Level	
1951	13	6.19	61.6					22.6
1952	24	5.01	68.5	70.1*	118.0°	±24.0°	69.3 to 166.7°	14.8
1953	47	6.55	76.0	†	51.3	±13.1	24.8 to 77.8	7.1
1954	57	5.52	69.6	69.0	100.5	±34.3	31.9 to 169.1	16.9
1955	66	3.26	21.7	16.2	23.8	± 6.0	11.8 to 35.6	10.2
1956	50	3.29	23.3	12.1	19.8	± 8.0	3.7 to 35.9	8.5
1957	43	4.51	50.4	84.5	139.0	±33.0	72.3 to 205.7	24.2
1958	48	4.14	43.2	72.0	109.6	±29.7	49.9 to 169.3	21.0

°1951-1952 data were combined.
†Data for 1953 were not used because they were not considered representative; vegetation made seining difficult, and temporary regulations designed to protect waterfowl food plants prohibited seining in some areas.

fish out of the lake prior to the fall of 1955. We have been led to believe that both carp and gizzard shad moved in and out of Lake Chautauqua during periods in which the lake was connected with the river and that they remained in the lake when acceptable niches there were available to them.

CRAPPIES: POPULATION CHANGES.—In the period 1950–1954, we tagged 2,963 white crappies at Lake Chautauqua. From these tagged fish we obtained 61 returns, all of which were taken from the lake. The tagging study indicated that the white crappie population at Lake Chautauqua was not mobile and that the fish tended to remain in the lake, even though ample opportunity was afforded them to move out during periods of high water.

We also tagged 1,332 black crappies at Lake Chautauqua. Only 10 returns were obtained from these tagged fish. Eight of the returns were from fish recaptured in the lake, and two were from fish taken in the Illinois River. In a period of 121 days, one tagged black crappie (7.2 inches total length) left the lake and moved 35 miles up the Illinois River, where it was caught by an angler. The other tagged black crap-

pie recovered in the river was caught in a commercial net 3 miles from the point of release in the lake 147 days after being tagged. The few returns we obtained indicated that the black crappie was more mobile than the white crappie.

The adult crappie population (both species) at Lake Chautauqua was estimated from tag returns to have been 100 pounds per acre in 1950 and 40 pounds per acre in 1951. Data from our fall netting studies (Table 39) indicate that in several years the population was probably as low as 10 or 15 pounds per acre. The large population of crappies in the fall of 1950 was composed mainly of 3-year-old fish from the large and dominant broods of both species spawned in 1948 (Fig. 25 and 26). The 1948 brood of white crappies was much larger than the 1948 brood of black crappies.

The aging studies presented earlier in this paper showed that very few white crappies in Lake Chautauqua lived to be more than 5 years of age. Comparison of data from spring angling (Fig. 24) with data from fall test-netting (Fig. 25) indicates that a high natural mortality of adult crappies oc-

Table 39.—Data relative to the crappie population at Lake Chautauqua, 1950–1959. The standing crop was estimated through tagging operations.

Year	Number Caught by Anglers	Average Catch Per Fisherman-Day	Average Catch Per Hour	Number of Adults Caught Per Net-Day in Test-Nets	Estimated Standing Crop in Pounds Per Acre in Fall Period	Pounds Caught and Removed Per Acre by Anglers
1950	10,096	1.0	0.19	36.2	100	0.8
1951	35,496	2.6	0.46	14.5	40	3.0
1952	18,422	1.5	0.26	18.9	..	2.3
1953	12,510	2.2	0.43	8.7*	..	1.6
1954	32,151	2.4	0.41	11.9	..	5.4
1955	16,622	1.5	0.36	4.4	..	2.1
1956	7,664	1.0	0.17	3.6*	..	1.2
1957	15,998	1.5	0.27	9.2	..	1.7
1958	4,110	0.5	0.09	12.7	..	0.4
1959	4,216	0.7	0.12	3.1*	..	0.3
Average	15,729	1.5	0.28	12.3	..	1.9

*Vegetation and low turbidity in this year reduced the efficiency of nets.

curred at Lake Chautauqua during the warm months of certain years. For example, fish of the 1955 year-class as 3-year-olds made up a large part of the anglers' catch of white crappies in the spring of 1958 (Fig. 24); at the end of the summer of 1958, fish of this year-class as 4-year-olds made up only a small part of the catch in test-nets (Fig. 25). Hansen (1951:249) suggested that heavy mortality in one or more broods of white crappies took place in the summer months of his study at Lake Decatur, Illinois.

The 1950 and 1951 test-netting, commercial seining, angling, and tagging data were of value in assessing the mortality of the large 1948 brood of white crappies. In the fall of 1950, the 1948 broods of crappies (both species), which had just completed their third summer of growth, dominated the net catches (Fig. 25 and 26); the estimated standing crop of the 1948 brood of white crappies was 70 pounds per acre. The entire adult crappie population (both species), as shown in Table 39, was estimated to average 100 pounds per acre. Test-net data showed that 74.1 per cent of the crappies were whites and 25.9 per cent were blacks.

In the fall of 1951, the estimated standing crop of all white crappies was 30 pounds per acre, while the estimated standing crop of the 4-year-old white crappies of the 1948 brood was 16 pounds per acre. In the fall of 1951, white crappies comprised 75.3 per cent of the crappie population and black crappies 24.7 per cent. We estimated that the 1948 brood of white crappies lost 60 to 75 per cent of their numbers during their third year of life. About 95 per cent of this loss was caused by natural mortality and about 5 per cent through fishing (sport and commercial).

Hansen (1951:249) found in two broods of white crappies at Lake Decatur a major decline in numbers when the fish were approximately 3 years old. At Clear Lake, in Minnesota, Scidmore

(1955:1) found that the mortality of crappies (mainly black) was "rapid after the fourth year." At Lake Chautauqua, the high mortality rate among white crappies during their third year of life prevented us from even attempting to make estimates of the mortality rates for the smaller broods that occurred in the lake after the passing of the 1948 brood. The high mortality rate estimated above for the large 1948 brood during its third summer of life may apply also to the small broods; a scarcity of white crappies over 3 years of age was evident in the net collections after 1954 (Fig. 25).

The factors involved in the extended survival of an extremely large brood, like that of 1948, were not detected in our study. Scidmore (1955:1) found evidence that a drastic reduction in the size of the adult population of crappies (black) was related to the establishment of a dominant year-class. He noted that a dominant year-class was usually separated from the next dominant year-class by 2 or more years. Thompson (1941:209) believed that a 4- or 5-year cycle of size and abundance occurred in fish populations at Lake Senachwine, Illinois. He hypothesized that a large, new year-class of crappies appeared at Lake Senachwine after natural mortality had reduced the preceding dominant year-class to such a low level that its cannibalistic food requirements had little effect upon the survival of its own young.

As has been pointed out earlier in this paper, only one extremely large or dominant brood of crappies (both species) appeared in Lake Chautauqua during our study. The crappies at Lake Chautauqua in 13 years failed to show any tendency toward being cyclic in their abundance. The species composition data presented graphically in Fig. 30, which is based on creel census data, give evidence that the adult populations of crappies, bluegills, and yellow bass fluctuated widely. Each of these species at one time or another domi-

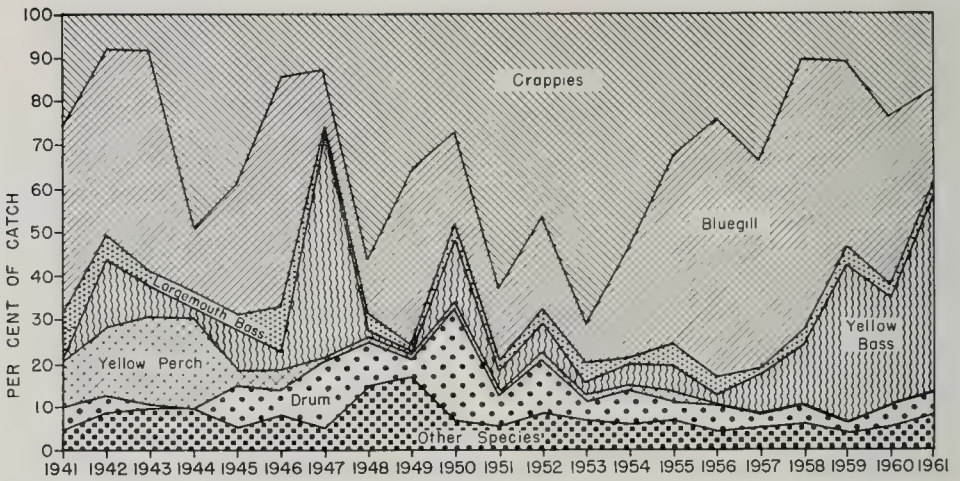


Fig. 30.—Species composition of fish in the anglers' catches at Lake Chautauqua, 1941-1961. The graph, which is based on numbers of fish, gives evidence that the adult populations of crappies, bluegills, and yellow bass fluctuated widely in the 21-year period.

nated the catch. Fishing conditions undoubtedly had some effect on the species composition shown in the graph; however, anglers at the lake usually fished for the species that were abundant, and upon this basis we believe that the graph gives a fairly accurate picture of the natural fluctuations in abundance of the sport fishes of catchable sizes.

BLUEGILL AND YELLOW BASS: POPULATION CHANGES.—The catch data presented in Table 40 indicate that the adult bluegill population of Lake Chau-

tauqua was larger in the 1954-1959 period than at any other time during the study. During much of this period of high bluegill population, the crappie and yellow bass populations were comparatively low (Fig. 30). Over most of this period, the yellow bass population was evidently increasing in size and in 1961 it was large enough to dominate the anglers' catch.

WHITE BASS: POPULATION CHANGES.—The tagging studies at Lake Chautauqua indicated that the white bass population was quite mobile. During pe-

Table 40.—Data relative to the anglers' catch of bluegills at Lake Chautauqua in the period 1950-1959.

Year	Number Caught	Average Catch Per Fisherman-Day	Average Catch Per Hour	Average Weight in Pounds	Pounds Caught and Removed Per Acre of Water
1950	7,626	0.7	0.14	0.27	0.6
1951	9,335	0.7	0.12	0.31	0.8
1952	8,316	0.7	0.12	0.37	0.9
1953	1,680	0.3	0.06	0.37	0.2
1954	15,787	1.2	0.20	0.37	1.6
1955	21,838	2.0	0.36	0.37	2.3
1956	18,892	2.4	0.43	0.40	2.1
1957	22,220	2.1	0.38	0.40	2.5
1958	23,408	2.8	0.50	0.26	1.7
1959	15,526	2.4	0.43	0.23	1.0
Average	14,463	1.5	0.27	0.34	1.4

riods of high water, large numbers of white bass moved out of Lake Chautauqua into the Illinois River. Of 605 white bass tagged and released in Lake Chautauqua, 31 were recovered. Only 12 of the tag returns were from fish recaptured in the lake. The other returns were from fish collected in the Illinois River and in other waters connected with the river. One tagged white bass moved out of the lake into the Illinois River and thence up Spoon River, a distance of 20 miles, within 8 days. A similar observation was recorded by Barber (1952:115) on a white bass tagged and released in the Kentucky River. This fish moved 20 miles from its point of release in 13 days.

The short life span and limited spawning success of the white bass in Lake Chautauqua made the species of varying importance as a predator during our investigation. This fish was probably of some importance as a predator on young gizzard shad and to a lesser extent on other forage species in 1950-1952 and 1954-1956. (Only limited food studies were made.) It is doubtful if the species was abundant enough in other years to have had much effect as a predatory species.

GROWTH AND CONDITON OF FISHES

The data presented in preceding sections of this paper indicate that the sizes of the populations of the abundant fishes in Lake Chautauqua varied from year to year during the period of our study. The variations apparently were related to several factors involving the fish: (i) natural mortality, (ii) mortality due to fishing, (iii) spawning success, (iv) absence or presence of large or dominant year-classes, (v) recruitment of individuals from the Illinois River and escape of individuals from the lake to the river, (vi) competition between species, and (vii) growth.

Factors Affecting Growth and Condition

In this section, water levels and vegetation, population density, and fish re-

moval are considered as possible factors affecting year-to-year changes in the growth and condition of the abundant species of fish at Lake Chautauqua.

WATER LEVELS AND VEGETATION.—The most apparent abiotic factor affecting the ecology of Lake Chautauqua during the years of our study was the fluctuating water level caused by overflowing of the Illinois River into the lake during periods of high river stages. During the 1950-1959 period, the normal pool stage of the lake was 435.0 feet above mean sea level (5.0 feet on the graphs in Fig. 31). The Illinois River overflowed into Lake Chautauqua when the river reached a stage of about 437.5 feet on the gauge at the lake (7.5 feet on the graphs in Fig. 31). The graphs show that fluctuations of river stages had no effect on the water levels of the lake until the stage of 437.5 feet was reached. At this stage and higher, the lake levels fluctuated with the river. The number of days each year in the months of June, July, and August that water levels were 437.5 feet or higher are given in Table 41. These numbers closely approximated the length of time during each summer of the investigation that the river was connected with the lake and that high water levels existed in the lake. Our measure of the effect water levels had on growth and condition of fishes was based on the number of days the lake stage was 437.5 feet or higher (Table 41).

At Lake Chautauqua, low water levels in summer were associated with abundant growth of sago pondweed, which, in turn, was associated with low turbidity. Estimates made of the abundance of sago pondweed in the lake in the months of June, July, and August are given in Table 41. Sago pondweed began to appear in the lake in May and continued to be present until late October or early November, if water levels remained low and stable. During our investigation, heavy growths of sago pondweed occurred in the lake in

the summers of 1953, 1956, and 1959. Those were the only years in which water levels remained low from June through August (Table 41). Jackson & Starrett (1959:161-163) found that turbidity in the lake was lower when vegetation was abundant than when it was absent. We may assume that lower turbidities occurred in the summer months of 1953, 1956, and 1959 than in the other years of the program. In those years the vegetation provided a habitat for a large population of *Tendipedidae* larvae and other insects that are eaten by fish.

Water levels were considered by us as a density-independent factor affecting the condition and growth of bluegills, crappies, and possibly other species of fish in Lake Chautauqua. During growing seasons in which vegetation abounded throughout the lake, crappies and bluegills were found in our seining operations to be well distributed in the lake.

In years in which vegetation was scarce or absent as a result of high water levels in summer, we took very few bluegills and crappies in our September seine hauls. Test-netting indi-

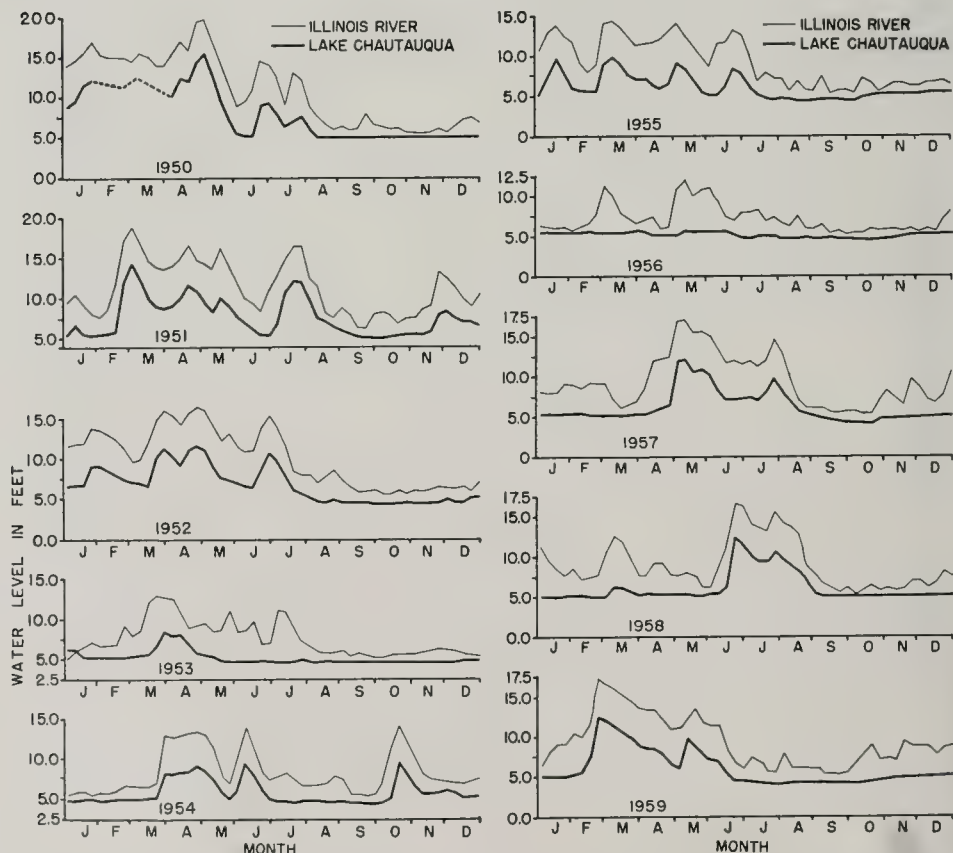


Fig. 31.—The water levels or stages of the Illinois River and of Lake Chautauqua, 1950–1959. Pool stage at Lake Chautauqua during the growing season was 435.0 feet above mean sea level, or 5.0 feet as shown on the graphs. The river overflowed into the lake at a stage of about 437.5 feet above mean sea level. The graphs (except part of the graph for 1950) were based on weekly summaries of water level data. They show the fluctuations that occurred in water levels and the effects of the river stages on water levels at Lake Chautauqua. The broken line in the graph for 1950 represents estimated levels during a short period in which no readings were taken.

cated that these species were in areas of the lake in which stumps and other suitable habitat were present. The amount of vegetation (or the absence of it) appeared to us to control the amount of suitable space available to

cupied by the fish (the slowest growth in the most densely populated lake).

Pirognikoff (1927:17) reported that the growth rate of the Siberian dace in Lake Chani (West Siberia) had been retarded considerably in a compara-

Table 41.—Number of days each year, 1950 through 1959, in which lake level elevation was 437.5 feet above mean sea level or higher, and the maximum elevation attained during the months of June, July, and August at Lake Chautauqua; also, the abundance of sago pondweed. At the stage of 437.5 feet, the lake was connected with the Illinois River.*

Year	Number of Days at 437.5 Feet or Higher	Maximum Lake Level Elevation in Feet (Above Mean Sea Level)	Abundance of Sago Pondweed†
1950	26	440.5	Absent
1951	32	442.1	Absent
1952	23	441.0	Absent to sparse
1953	0	434.8	Abundant
1954	15	439.7	Sparse to abundant
1955	12	438.6	Moderate
1956	0	435.1	Abundant
1957	28	440.3	Absent to moderate
1958	64	442.7	Absent to sparse
1959	1	437.5	Abundant

*The normal pool stage of Lake Chautauqua is 435.0 feet above mean sea level.
†Abundance was determined as described in Jackson & Starrett 1959:157; the terms *abundant* and *heavy* are equivalent.

bluegills and crappies, and therefore probably the carrying capacity of the lake for these species.

In a growing season in which the water levels were low and the vegetation was abundant, the carrying capacity of the lake was probably much higher for bluegills, crappies, and possibly other fishes, than in a growing season in which water levels were high or fluctuating and the vegetation was scarce or absent.

POPULATION DENSITY AND FISH REMOVAL.—Some fisheries biologists have recognized population density as an important factor in the growth rate of fishes (Hile 1936:253–262 and others).

Hile (1936:262) reported that the growth rates of four separate populations of cisco in Wisconsin were determined primarily by the densities of the populations rather than by the basic productive capacities of the waters oc-

tively short period and stated that A. I. Beresovsky, Manager of the Siberian Ichthyological Laboratory, attributed the retarded growth to a decline in fishing activity and the resulting overpopulation of the lake. Pirognikoff stated further that Beresovsky considered intensified fishing activity as a radical measure for correcting the situation.

Willer (1929:672–675), working in Germany, reported that the growth of trout was influenced by “space-factors” (Raumfaktors). Hile & Deason (1934:236) attributed slow growth of whitefish in a Wisconsin lake to density of the fish population. They stated: “The crowding may impede growth through the creation of intense competition for food or through the operation of a ‘space-factor.’”

Raitt (1939:78) observed close agreement between variations in growth rate and the degree of brood density of had-

dock in the North Sea—the smaller the brood the faster its rate of growth. Similarly, Bückmann (1939:26) found that in the German Bight the growth rate of the plaice was inversely proportional to the density of the stock of fish on the grounds. In Japan, Yoshihara (1952:59-60) investigated carp growth in nine ponds and found poor growth in ponds having dense populations.

Some investigators have reported a lack of inverse relationship between growth rate and population density of fish.

Hickling (1946:406-407) found that haddock stock on the Porcupine Bank (about 120 miles west of Ireland) after 4 years of no fishing in World War II was five times as dense as in the best years immediately before the war. The brood of 1942, existing under comparatively crowded conditions, grew no less rapidly than that of 1938; all the haddock examined were in excellent condition.

Le Cren (1949:258), in England, reported "no marked general increase in growth rate" in a population of perch at Lake Windermere after the population had been "severely reduced" by 8 years of trap fishery. He noted, however, that the mean lengths of the age groups of fish caught in the traps had shown significant variations from year to year and that the mean lengths were "somewhat greater" at the end of the 8 years than at the beginning.

Kawanabe (1958:178), in his studies of the "Ayu" in the River Ukawa, Japan, found that its growth was better in a dense population than in a thin one, and he concluded that "population density influences the growth of the fish, but it does so through the definite social structure peculiar to a species."

Concerning marine fish populations, Hjort (1932:5) wrote: "We may . . . safely conclude that the hypothesis of an inverse ratio between the number of individuals in a given population and the growth of these individuals is by no means of *universal* application."

Part of the concept of modern-day management of fish in warmwater lakes and ponds is based upon the hypothesis that an inverse ratio exists between the density of a population and the growth rates of individuals in that population, and that therefore growth rates can be increased by reducing the density through removal of individuals from the population.

Beckman (1941 and 1943) found an increase in the growth rates of rock bass in a Michigan lake after the fish population had been reduced through application of poison to one basin of the lake. In Alabama, Swingle, Prather, & Lawrence (1953) tried improving the growth rates of fish populations in overcrowded ponds by applying rotenone to parts of the ponds. Bennett (1954a: 251) reported maintaining relatively rapid growth of largemouth bass over a 10-year period at Ridge Lake, Illinois, by culling out the small bass and reducing the bluegill population during draining operations in alternate years.

Ricker & Gottschalk (1941:382) in Indiana and Rose & Moen (1953:104) in Iowa reported improved angling and increases in populations of game fish in warmwater lakes after populations of coarse fish in the lakes had been reduced with seines. Moyle, Kuehn, & Burrows (1950:163), who studied lakes from which some rough fish had been removed annually for 25 years, concluded: "In general, rough fish appear to have little effect on the total poundage of game fish in southern Minnesota lakes." In a later paper, Moyle & Clothier (1959:183-184) suggested that the decline in carp in Lake Traverse, Minnesota, might be related to the increase that occurred in crappies and bullheads in that lake.

In Massachusetts, Grice (1958:108) found that fyke netting of panfish and other nongame fish increased the growth rates of the species being thinned, but that it failed to improve the populations of game fish; where "removal was intensive, growth rates

of panfish increased markedly." Lam-bou & Stern (1959:54-55) found that soon after removal of rough fishes from a lake they studied in Louisiana the sunfish population became overcrowded, and a decrease occurred in the average weight of sunfish in the creel.

Scidmore & Woods (1961:12, 18) reported that even with almost continuous efforts to remove carp from Clear Lake, Minnesota, "the carp population recovered quite rapidly with a shift in population structure toward greater numbers of young fish." These writers concluded from their studies on several Minnesota lakes that no direct relationship could be found between the amount of rough fish removal and subsequent improvement in panfish populations.

Our Lake Chautauqua study, as discussed in the section below, "Growth and Condition Data," revealed either that (i) an intensive program of fish removal had little effect on population density or that (ii) growth and condition of the fish were influenced by more factors than population density. At the end of 4 or 5 years of our study, the growth and condition of bluegills, crappies, freshwater drum, and bigmouth buffalo showed improvement. Such improvement could, at that time, have been correlated with the increased removal of commercial fishes from the lake. By continuing the study over a longer period, we found that the improvement in growth and condition that was evident early in the study tended to be lost. Perhaps a more intensive removal program would have had a measurable effect upon the growth and condition of fishes in the lake. However, the program apparently was intensive enough to reduce the average lengths of bigmouth buffalo, freshwater drum, carp, and channel catfish taken in commercial seines.

Successful reproduction of certain fishes, particularly carp, bigmouth buffalo, gizzard shad, bluegill, and yellow bass, may have offset population reduc-

tions resulting from fish removal. Also, the lake probably recruited additional stocks of fish from the river during high water levels.

The annual yields of sport fish were approximately the same at the end of our fish removal program as at the beginning. Apparently the commercial removal of fishes did not greatly benefit or harm the sport fishery at the lake.

Growth and Condition Data

From length and age data in Tables 1, 9, 15, 18, 21, and 24, we derived indices of growth (as described on page 8) for each of six species of fish abundant at Lake Chautauqua in the years of our study. From data collected in the fall months, we derived indices of condition (C) or average annual fall condition factors (as described on page 7) for each of eight species, the six referred to above and two others (Table 42).

BLUEGILL: GROWTH AND CONDITION DATA.—The year-to-year variations that occurred in the average lengths of 3-, 4-, and 5-year-old bluegills in Lake Chautauqua are shown in Fig. 32 and Table 9. The indices of growth based on data in Table 9 are expressed graphically in Fig. 33.

The average lengths of 3-year-old bluegills tended to vary more from year to year than did the average lengths of older bluegills (Table 9 and Fig. 32). Fish of the three age-groups (3-, 4-, and 5-year) made better growth

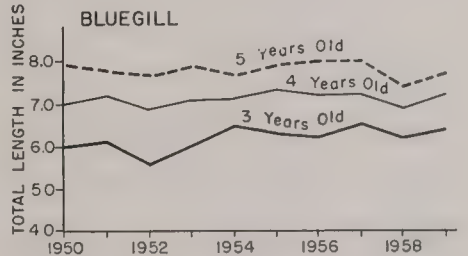


Fig. 32.—Year-to-year variations in growth rates (as indicated by length) of 3-, 4-, and 5-year-old bluegills at Lake Chautauqua, 1950-1959 (data from Table 9).

(as shown by average lengths) during the 1953-1957 period than during the preceding 3-year period or the following year, 1958. Although most of this period of good growth coincided with years of heavy removal of commercial fishes and shad from Lake Chautauqua (Table 5), we believe that commercial fish removal was not an important factor in the growth of bluegills in the lake. Our conclusion is supported by knowl-

edge that the heaviest removal of commercial species and shad from the lake came in 1957, the year before a marked drop in bluegill growth rate occurred. If the heavy removal of commercial species and shad had been responsible for good bluegill growth in the 1953-1957 period, then good growth should have continued through 1958. The period of good bluegill growth appears to have coincided with the pe-

Table 42.—Average annual fall condition (C) factors of the bluegill, white crappie, black crappie, carp, channel catfish, gizzard shad, bigmouth buffalo, and freshwater drum at Lake Chautauqua, 1950-1959.

Year	Bluegill		White Crappie		Black Crappie		Carp	
	Number of Fish	C Factor	Number of Fish	C Factor	Number of Fish	C Factor	Number of Fish	C Factor
1950	464	8.02	2,243	4.91	750	5.50	0	...
1951	53	8.35	1,183	5.13	161	5.68	307	5.39
1952	72	9.59	629	5.34	487	5.85	163	5.31
1953	137	9.37	503	5.80	138	6.32	167	5.12
1954	620	9.11	375	5.63	353	5.87	136	4.90
1955	218	10.03	147	5.60	259	6.27	241	4.72
1956	221	9.86	329	5.70	271	6.41	345	4.74
1957	299	8.38	405	5.03	196	5.54	387	4.82
1958	81	7.59	553	5.02	270	5.61	349	4.65
1959	248	8.49	264	5.48	238	5.90	0	...
Average or total	2,413	8.88	6,631	5.36	3,123	5.90	2,095	4.96

Table 42.—Continued

Year	Channel Catfish		Gizzard Shad		Bigmouth Buffalo		Freshwater Drum	
	Number of Fish	C Factor	Number of Fish	C Factor	Number of Fish	C Factor	Number of Fish	C Factor
1950	0	...	61	3.47	0	...	0	...
1951	90	3.45	0	...	292	6.44	358	4.98
1952	0	...	53	3.42	228	6.40	162	5.07
1953	160	3.43	140	2.75	208	6.22	341	5.26
1954	115	3.16	62	3.03	279	6.24	306	5.00
1955	306	3.28	118	3.38	274	6.40	392	4.52
1956	321	3.37	122	3.39	356	6.47	394	4.44
1957	316	3.14	257	3.23	426	6.64	370	4.64
1958	284	3.20	198	3.12	368	6.41	394	4.30
1959	0	...	0	...	0	...	0	...
Average or total	1,592	3.29	1,011	3.22	2,431	6.40	2,717	4.78

riod of largest catches per acre (and presumably of largest populations) of adult bluegills (Fig. 33). The occurrence of good growth with comparatively large populations of bluegills was

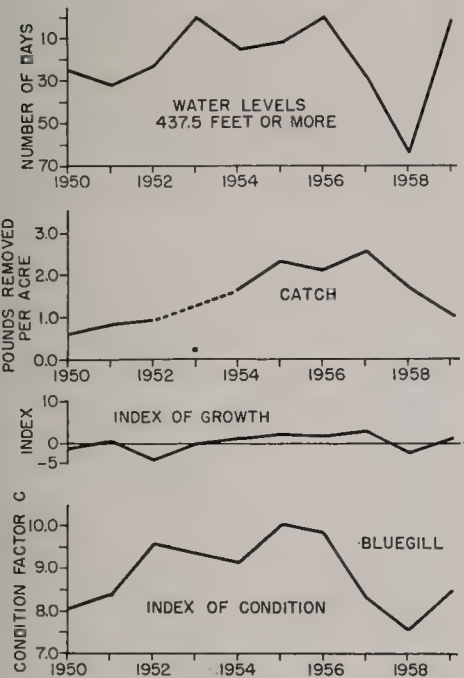


Fig. 33.—Trend in water levels at Lake Chautauqua (number of days water levels were at least 437.5 feet above mean sea level in June, July, and August, Table 41) and trends in population sizes (as reflected by anglers' catch, Table 40), indices of growth, and indices of fall condition (C) of bluegills at Lake Chautauqua, 1950–1959. The trend in the indices of condition was quite similar to the trend in water levels. Part of the curve representing catch is broken to indicate deviation from actual 1953 data (shown by a dot), which were considered inadequate and atypical.

believed by us to have been related to some density-independent factor that raised the lake's carrying capacity for bluegills. The factor involved here was, in our opinion, water levels. The best bluegill growth occurred in years (other than 1957) in which the water was low (and therefore relatively stable and low in turbidity) during the summer months (Fig. 33); even in 1957 the water was low, stable, and clear

long enough to permit moderate growth of vegetation in some places (Table 41). The sharp decline that occurred in growth of bluegills in 1958 was, in our opinion, a result of continued high water levels (and consequent high turbidity) during the growing season of that year. A slight negative correlation was found to exist between high water levels and growth index of bluegills ($r=-0.46$).

During the years 1953–1956, in which no, or only a few, days of high water levels occurred, the turbidity was comparatively low, and vegetative growth was moderate to abundant; vegetation provided cover, and, directly or indirectly, suitable space and food for fish. These conditions evidently were favorable to the growth of bluegills. Patriarche (1953:249), in discussing poor growth of bluegills in Lake Wappapello, Missouri, stated, "Presumably the lack of vegetation, unstable water levels, and competition for food curtail the insect and plant food supply upon which the bluegill depends."

The average annual fall condition factors of bluegills (Table 42) tended to follow a trend similar to that of the growth index (Fig. 33). Fall condition, like growth, declined sharply in 1958. We believe that, during the time of our study, water levels were the principal factor affecting fall condition, as well as growth. Condition values were lower in autumns following summers of high water levels than in autumns following summers of low water levels. The correlation coefficient of $r=-0.81$ indicated a rather highly significant negative relationship between high water levels of Lake Chautauqua and high average fall condition factors of the bluegill.

WHITE CRAPPIE: GROWTH AND CONDITION DATA.—The annual variations that occurred in the growth patterns of 2-, 3-, and 4-year-old white crappies in the years 1950–1959 at Lake Chautauqua are reflected in the average lengths of the fish in these age-classes (Table

15 and Fig. 34). The 2-year-old white crappies of 1950-1952 had smaller average lengths than the 2-year-olds of any other year of our study. The 2-year-old fish of 1953 showed a drastic increase in growth rate (as measured by

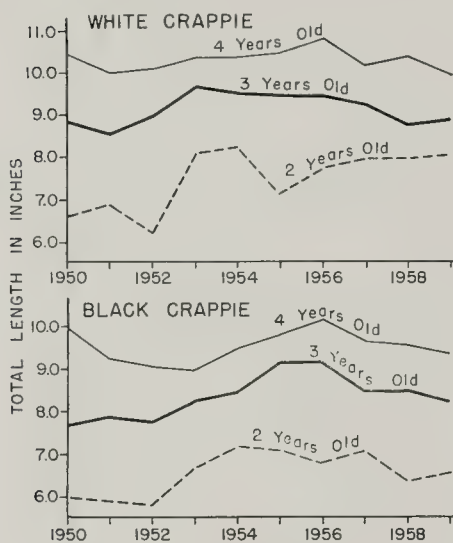


Fig. 34.—Year-to-year variations in growth rates (as indicated by length) of 2-, 3-, and 4-year-old white crappies and black crappies at Lake Chautauqua, 1950-1959 (data from Table 15 and Table 18).

average length in the fall), and 2-year-old fish continued to show good growth rates each year through 1959. The improved growth rates probably were related to the comparatively small populations of crappies present in the lake after 1952.

The average lengths of the 3- and 4-year-old white crappies varied less from year to year than the average lengths of the 2-year-olds. After 1956, the average lengths of the 3- and 4-year-old fish declined slightly. By 1958 and 1959, the average lengths of fish of these ages had dropped to about where they had been in 1950 and 1951. The length data given here on the 3- and 4-year-old white crappies indicate that the increased removal of commercial fishes had no apparent beneficial effect on growth of these crappies.

We did not find that any correlation ($r=-0.16$) existed between the growth indices of 3- and 4-year-old white crappies and the Lake Chautauqua water levels (Fig. 35). The calculated correlation coefficient may be misleading, since more than one age-group was involved in the computation. In 1953, a year of low water levels, the 2-, 3-, and 4-year-old fish showed increases in average lengths (Fig. 34). In 1956, a year of low water levels, the 2- and 4-year-old fish showed increases in average

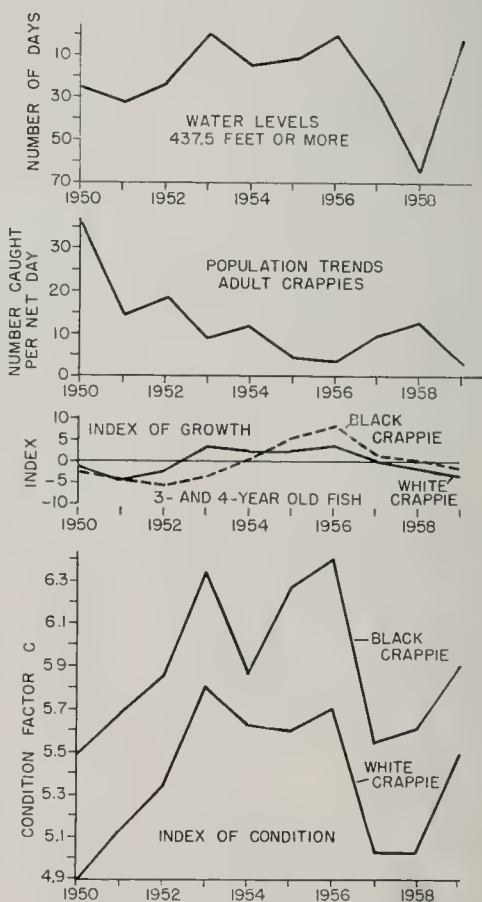


Fig. 35.—Trend in water levels at Lake Chautauqua (number of days water levels were at least 437.5 feet above mean sea level in June, July, and August, Table 41) and trends in population sizes (as reflected by test-netting, Table 39), indices of growth, and indices of fall condition (C) of white crappies and black crappies at Lake Chautauqua, 1950-1959.

lengths. In 1958, a year of high water levels, the 3-year-old fish showed a drop in average length. Both the 2- and 3-year-old fish showed increased average lengths in 1959, a year of low water levels. The 4-year-old fish showed a decrease in average length in that year; this decrease may have been caused at least partially by the small size of these fish as 3-year-olds in the previous year. The importance of the density-independent factor, water levels, on the white crappies of Lake Chautauqua is developed further in the following discussion on condition.

The average fall condition factor (C) of the white crappies of Lake Chautauqua ranged from a low of 4.91 in 1950 to a high of 5.80 in 1953 (Table 42). The 1950-1959 data indicate that a rather close negative correlation existed between high summer water levels and average fall condition factors of these crappies ($r = -0.79$). The graphs shown in Fig. 35 indicate that in an autumn following a summer of low water levels the average condition factor was high and in an autumn following a summer of high and fluctuating water levels the average condition factor was low. We believe that water levels acted as a density-independent factor that affected the Lake Chautauqua carrying capacity for fishes, such as crappies and bluegills, that feed by sight and tend to remain close to cover.

The low average condition of white crappies in the fall of 1950 demonstrated the effect of lowered carrying capacity (created by high water levels the previous summer) combined with high population density. In the summers of 1957 and 1958, water levels of Lake Chautauqua were high, and the carrying capacity of the lake was consequently reduced. In these years, the population density of white crappies was comparatively low, and, although the fall condition of the fish was low in both years, it was not so low as it had been in 1950, when the population density of crappies was high.

Increased removal of commercial fish apparently had no effect upon the average fall condition factor of white crappies, inasmuch as this factor was low in 1958, the year following an extensive removal of commercial fish, the largest removal of the entire research program (Table 2).

BLACK CRAPPIE: GROWTH AND CONDITION DATA.—The annual growth patterns of 2-, 3-, and 4-year-old black crappies are presented with those of the white crappies in Fig. 34. The 3- and 4-year-old black crappies showed more variation in growth rates than did white crappies of the same age-groups. The large and dominant 1948 brood of crappies, together with high water levels, seems to have had more effect on growth of the black crappies than it did on growth of the whites. In the fall of 1950, the dominant brood, which was then classified as 3 years of age, had the smallest average length recorded during the study for black crappies of that age (Table 18). As might have been expected, fish of the 1948 brood had a low average length as 4-year-olds in 1951. In 1953, the black crappies of the 1950 brood made poor growth, as shown by their average lengths in the fall as 4-year-olds, whereas fish of most other age-groups of both species showed marked improvement in their growth rates. Possibly fish of the 1948 broods of both species were still present in sufficient numbers in 1953 to affect the growth of black crappies of the 1950 brood. The poor growth of black crappies in the period 1950-1952 was probably related to the large numbers of crappies in the population at that time and to high water levels. Three- and 4-year-old black crappies showed improvement in growth in the years 1954-1956 (Fig. 34 and Table 18).

After 1956, the average lengths of the 3- and 4-year-old crappies of both species declined. The 2-year-old black crappies exhibited a growth pattern quite similar to that of white crappies of the same age. After 1952, 2-year-olds

of both species continued to show increases in average length (Fig. 34). The relatively small number of 2-year-old crappies after 1952, coupled with years of low water levels, evidently favored the growth of crappies in their second summer of life.

As shown by condition factors (Table 42), the black crappie at Lake Chautauqua in the years of our study was a plumper fish than the white crappie. The two species made similar year-to-year changes in plumpness or condition (Fig. 35).

Like the white crappie, the black crappie had fall condition values that were negatively correlated with high water levels ($r=-0.73$). The relationship between water levels and average fall condition factors (Fig. 34) discussed above for the white crappie is applicable to the black crappie.

CHANNEL CATFISH: GROWTH AND CONDITION DATA.—The year-to-year variations that occurred in the average lengths attained by 4-, 5-, and 6-year-old channel catfish of Lake Chautauqua are shown in Fig. 36 and Table 21. Each year, 1953–1956, the 4-year-old channel catfish showed increases in average length, but in the following 2-year period they showed decreases. The period of good growth coincided with a period of summers of comparatively low water levels (Table 41). We believe that during this period the carrying capacity of the lake for catfish increased as a result of the low water levels. During part of this period, the size of the catfish population (as determined by the catch per acre seined) was relatively high (Table 35); normally the large population would have had an adverse effect on growth of the fish if the carrying capacity of the lake had not been increased. Part of this period of good growth rates of 4-year-old catfish was in the years of increased removal of catfish and other fish (Fig. 37 and Table 5). However, had removal of fish been the principal factor involved here, growth rates of 4-year-old fish

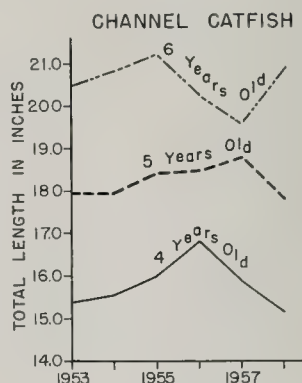


Fig. 36.—Year-to-year variations in growth rates (as indicated by length) of 4-, 5-, and 6-year-old channel catfish at Lake Chautauqua, 1953–1958 (data from Table 21).

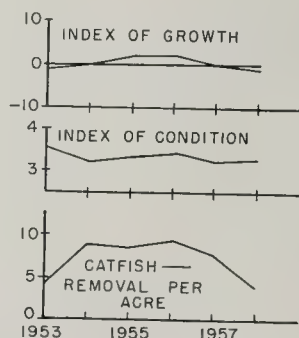


Fig. 37.—Patterns of growth and fall condition (C) of channel catfish in Lake Chautauqua and number of pounds of catfish removed per acre from the lake, 1953–1958 (fish removal data from Table 35).

should have continued to be good through 1957 and 1958 (instead of decreasing in 1957 and 1958), since 1956 and 1957 were years of extensive removal of fish, including catfish.

The 5-year-old channel catfish followed a pattern of average lengths similar to the pattern followed by the 4-year-olds except in 1957, when an increase rather than a decrease in average length occurred (Fig. 36). The increase in 1957 was made by 5-year-old fish of the 1953 year-class and may be explained in part, at least, by the unusually good average length of individuals of this year-class as 4-year-old fish in 1956. In 1958, fish of the 1953 year-class

as 6-year-olds were larger than fish of the 1952 year-class were in 1957; the 4- and 5-year-old fish were smaller in 1958 than in 1957. We cannot explain why the average length of the 6-year-old fish dropped in 1956 while the average lengths of the 4- and the 5-year-olds showed increases.

The indices of growth of 4-, 5-, and 6-year-old channel catfish (Fig. 37) showed a slight negative correlation with the high water levels of Lake Chautauqua ($r = -0.47$).

Only very slight variations occurred from year to year in the average fall condition factors of channel catfish (Table 42 and Fig. 37). The small changes that occurred in condition indicated a slight negative correlation with high water levels ($r = -0.39$). Finnell & Jenkins (1954:20-21) and Buck (1956:46) found that turbidity retarded the growth of channel catfish in Oklahoma. At Lake Chautauqua, the relatively clear waters during the growing seasons in years of low water evidently had some beneficial effect on condition and growth of channel catfish.

GIZZARD SHAD: CONDITION DATA.—The average fall condition factors for gizzard shad at Lake Chautauqua, as determined from length and weight data collected in September and early October, 1950 and 1952-1958, showed little variation, except in 2 years of low condition factors, 1953 and 1954 (Table 42). The increased removal of fish during the 1954-1957 period (Table 5) apparently had no desirable effect on the average fall condition of shad; the condition values were lower in 1956, 1957, and 1958 than in 1950 and 1952 (Table 42). The increase in abundance of adult shad after 1953 apparently had some effect upon the condition of the shad, since average fall condition factors after that year were not as high as they had been in 1950 and 1952 when the adult populations, as measured by the catch, were small (Table 37).

The fluctuations in average condition factors of gizzard shad in the autumns

of 1950-1958 showed no significant correlation with the high water levels of the respective preceding summers ($r = +0.10$). The low condition value in the fall of 1953 followed a summer of low water levels (Table 41). This low condition value was possibly related to the large brood of bigmouth buffalo spawned in 1953.

BIGMOUTH BUFFALO: GROWTH AND CONDITION DATA.—The average lengths that the 4-, 5-, and 6-year-old buffalo at Lake Chautauqua attained in the period 1951-1958 are shown in Fig. 38 and Table 24. Other than in 1953 and 1954, the year-to-year trends in average

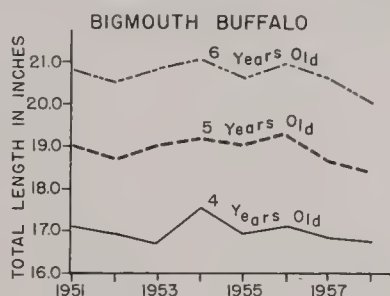


Fig. 38.—Year-to-year variations in growth rates (as indicated by length) of 4-, 5-, and 6-year-old bigmouth buffalo at Lake Chautauqua, 1951-1958 (data from Table 24).

length of individuals in the three age-groups were quite similar. The decline in average length of the 4-year-old fish in 1953 may have resulted from competition with the large population of buffalo spawned in that year.

The variations that occurred from year to year in average length of the buffalo were small. The average lengths, other than length of the 4-year-old fish in 1953, tended to be greater in the 1953-1956 period than at any other time in the study except possibly 1951 (Table 24). With few exceptions, the years of good growth of buffalo (as measured by average length in the fall) coincided with years in which the summer water levels were low (Tables 24 and 41 and Fig. 38). The range in the indices of growth was minor (-2.6 to

+2.0). The increased removal of fish during the investigation apparently did not increase the growth rate of bigmouth buffalo; the average length of buffalo was slightly less in 1958 than at the beginning of the removal program in 1951 (Fig. 38 and Table 24).

The variations that occurred in the average fall condition factors for bigmouth buffalo (Table 42) were quite small but were more pronounced than those noted for the indices of growth. The lowest average fall condition factors for the bigmouth buffalo, as for the gizzard shad, occurred in 1953 and 1954. From 1951 through 1958, high summer water levels seemed to have a minor effect on the average fall condition factors ($r = +0.30$). After 1954, the C factors for buffalo increased slightly each year until 1958, when the factor dropped to 6.41, a figure close to that calculated for the year 1955. If the increased removal of buffalo and other fishes had been responsible for the slightly higher condition values in the years 1955–1957, then the C value should have been high in 1958, since more fish were removed from Lake Chautauqua in 1957 than in any other year during the program (Table 5).

FRESHWATER DRUM: GROWTH AND CONDITION DATA.—The average lengths of the 3-, 4-, and 5-year-old drum at Lake Chautauqua varied only slightly from year to year in the 1951–1954 period (Fig. 39 and Table 1). In 1955, declines occurred in the average lengths of fish of all three age-groups—sharp declines in the 3- and 4-year-old fish. In the following year, average lengths of the 3- and 4-year-old fish increased to about the levels of the years before 1955. The average length of the 5-year-old fish in 1956 was slightly less than the average length of this age-group in 1955. The decrease in average length of this age-group in 1956 may have been a result of the small size of the individuals the preceding year as 4-year-olds. In 1957, all three age-groups increased in average length. The 4-year-

old fish of 1957 were larger than those of any previous year. In that year the 3- and 5-year-olds were approximately as large as in any earlier year. In 1958, the 3-year-olds were larger than in any other year of the study. The 4- and 5-year-olds were much smaller than in 1957.

The sharp decline that occurred in average length of drum individuals in 1955 followed the year of the largest removal of drum (73,197 pounds, Table 5) during the entire fish removal program. Another decline in average length of drum occurred in 1958, a year after the largest removal of fish (all of the species combined). The population density of drum (as indicated by catch per 100 yards of seine) was at its lowest in 1958 (Table 34). Water levels did not seem to have any noticeable effect on growth rates. The factors affecting the growth rates of the drum at Lake Chautauqua were not apparent to us.

The average fall condition factor of freshwater drum at Lake Chautauqua was at its highest in 1953 (Fig. 40 and Table 42). In 1954, the condition factor dropped to approximately its level in 1951. Then, in 1955, the condition factor made a sharp decline and did not recover to the 1954 level during the 1955–1958 period.

In 1955 and subsequent years, fish buyers in Chicago reported back to us that the flesh of some of the drum from Lake Chautauqua was “hard-meated”

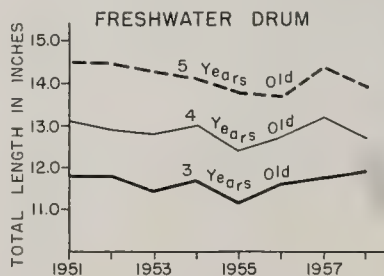


Fig. 39.—Year-to-year variations in growth rates (as indicated by length) of 3-, 4-, and 5-year-old freshwater drum at Lake Chautauqua, 1951–1958 (data from Table 1).

(rubbery). This condition affected the sale of drum from the lake, and the local wholesale undressed price dropped from about 8 cents to 3.5 cents a pound. Prior to 1955, we had never received a complaint regarding the flesh of drum from Lake Chautauqua. The low average fall condition factor of drum in the 1956-1958 period occurred during the years the population density of drum (as estimated by catch per 100 yards of seine) was relatively low. The poor condition of drum in the 1956-1958 period occurred during and following the time of the most extensive removal of fish (all kinds) from the lake. At Lake Winnebago, Wisconsin, Wirth (1958:32) observed an improvement in the condition of drum following a drastic reduction of drum stocks—"little improvement" in the first 3 years of a removal program but "a decided change" in the next 2 years.

In most years of our study, we found little relationship between water levels of Lake Chautauqua and average fall condition factors of the freshwater drum in the lake (Tables 41 and 42). This finding is not surprising, since, according to Langlois (1954:262), adult drum can find their food by taste and smell. Possibly at Lake Chautauqua, high turbidity resulting from high water and the absence of vegetation would not seriously interfere with feeding.

One factor that possibly affected the condition of drum was the increase in abundance of carp, gizzard shad, and

bluegill that occurred after 1952, following the extensive removal of buffalo. The effect of the increase in abundance of these species cannot be proved.

Another factor that may have affected the condition of drum in Lake Chautauqua was a change in abundance of food. This change may have affected the condition of carp, also. The effect of this change is developed for both carp and drum in the following paragraphs.

CARP: CONDITION DATA.—After 1953, the average fall condition factors of drum and carp followed rather similar downward trends (Fig. 40). These species were the only ones studied that exhibited such trends in condition after 1953. We suspect that the condition of both species was affected by the same factor or factors. As suggested above, the decline in condition may have been caused by a change in abundance of food.

Since 1956, commercial fishermen have complained that a large percentage of the carp caught in the Illinois River were too small for commercial sale. The predominance of small carp has damaged the Illinois River commercial fishery. In 1957, we began to study the growth rate of carp in the river. We found this growth rate to be relatively poor for the middle and upper reaches of the Illinois. Small size and low condition of the Illinois River carp, we found, were related to this poor growth rate. A decrease in the general

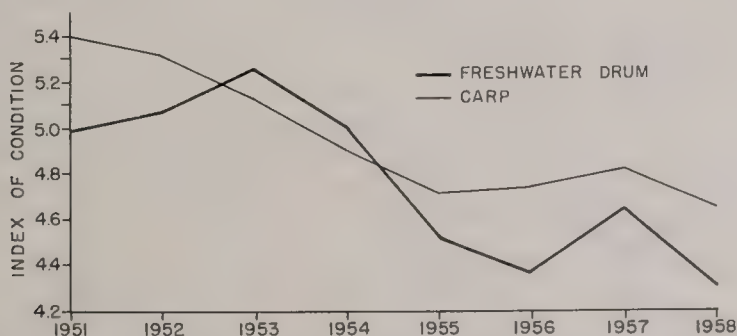


Fig. 40.—Average fall condition (C) factors of carp and freshwater drum at Lake Chautauqua, September, 1951-1958.

well-being of carp in the river was paralleled by a decline in the condition of carp and drum in Lake Chautauqua.

Paloumpis & Starrett (1960:422-424) reported that the population of fingernail clams (*Sphaeriidae*) in lower Quiver Lake (part of the Illinois River) dropped from 1,115 individuals per square foot in 1952 to 54 per square foot in 1953 and to 0 in 1954. The snail population in lower Quiver Lake also declined in this period. Fingernail clams virtually disappeared from Lake Chautauqua after 1954. In a recent study (unpublished), Starrett & Paloumpis found that the principal foods available to carp in the middle Illinois River were *Tubificidae* worms, filamentous algae, *Entomostraca*, phytoplankton, and, to a limited extent, insect larvae.

Forbes & Richardson (1920:106) considered carp as "omnivorous feeders, taking principally vegetable matter, but insect larvae, crustaceans and mollusks, and other small aquatic animals as well." Moen (1953:675) found in his detailed study of the food habits of carp in Iowa lakes that aquatic insect larvae, small crustaceans, and snails formed the bulk of the animal foods consumed during the summer periods. Richardson (1928:471) considered the increase of small *Sphaeriidae* (fingernail clams) that occurred in the Illinois River as a result of pollution as beneficial to the "coarse fish" by affording them a greater supply of food. We believe that the fingernail clams in the Illinois River formerly furnished an important source of food for carp and that with the virtual disappearance of the fingernail clams in the river in about 1953 the growth of the carp in that river was affected adversely.

We have hesitated even to conjecture that the decline in condition of carp and drum in Lake Chautauqua was related to the reduced fingernail clam population in that lake, as may have been the case with the growth of carp in the Illinois River. Darnell (1958:

381) reviewed the literature on the food habits of drum and stated that "the smallest individuals feed upon entomostracans. These are followed by aquatic insects, and the large drums feed chiefly upon clams and snails, supplemented by crayfish and other materials." Darnell examined four drum from Lake Pontchartrain, Louisiana, that contained food and found that about 73 per cent of the stomach contents consisted of clams, 11 per cent mud crabs, 10 per cent undetermined organic material, and 6 per cent amphipods. He also found traces of blue crabs, gastropods, hydroids, and leaves and twigs of vascular plants. Dendy (1946:117-118), who studied the food habits of drum in Norris Reservoir, Tennessee, reported that when mollusks were not available drum substituted fish for the mollusks that were normally part of their diet.

Two detailed food habits studies, one by Daiber (1952:38) on Lake Erie and the other by Moen (1955:593) on four Iowa lakes, indicated that insect larvae, crustaceans, and fish comprised the bulk of the food taken by drum. Mollusks were available to the drum in Lake Erie, but Daiber (1952:39) found no evidence that they were used for food by the drum. Moen (1955:591) reported that mollusks (*Gastropoda*) formed only about 3 per cent of the total volume of food in the stomachs of the drum collected from the four Iowa lakes. Fingernail clams were present in the lakes, but Moen found none in the stomachs of the drum.

No detailed food habits study was made of drum at Lake Chautauqua; the few stomachs of drum collected from this lake after 1954 and examined by us contained insect larvae and fish. Benthic studies made at Lake Chautauqua by Paloumpis & Starrett (1960:417) indicated that each year in the period 1952-1956 the lake supported a large population of dipterous larvae. Small-size fish that might have served as forage for drum occurred abundantly

each summer during the study. The insect larvae should have been abundant enough to furnish an adequate food supply for carp. However, in spite of the abundance of food in the lake, other than mollusks, the condition of carp and drum declined. In 1957 (Fig. 40), the C values of these species showed some improvement and then declined again. At Quiver Lake, there was a temporary increase in the fingernail clam population in 1957 (Paloumpis & Starrett 1960:425). Bottom fauna studies were not conducted on Lake Chautauqua in 1957. Possibly the fingernail clam population increased that year in Lake Chautauqua as well as in Quiver Lake. Whether an increase in the clam population might have been related to the 1957 increase in the condition values of carp and drum can only be speculated.

The literature reviewed above on the food habits of drum indicates that there is a conflict of opinions among biologists as to the importance of Mollusca in the diet of the drum. In the event that even small quantities of Mollusca are a nutritional requirement in the diet of carp and drum, then the decrease in the Mollusca population that occurred in Lake Chautauqua in the years of our study could have had an adverse effect on the condition values of these fishes in the lake.

EFFECTS OF FISH REMOVAL
ON FISHING

The effects of an intensive fish removal program on the growth and condition (C) of fish and on the size of fish populations at Lake Chautauqua have been discussed in the preceding sections. The effects that increased intensity of commercial fishing had on commercial and sport fishing are presented below.

Effect on Commercial Fishing

The possible effects that the increased fish removal had on size of commercial species are discussed in another section,

“Growth and Condition Data.” The changes that occurred from year to year in the mean weights of the four principal commercial species are given in Table 43. The decreases in the weights of these species occurred concurrently with the increased fishing pressure and are quite apparent. In some species, decreases in size and weight would eventually have occurred because of natural

Table 43.—Mean weights (pounds) of commercial fishes caught in commercial seine hauls in September at Lake Chautauqua, 1951–1958.

Year	Channel	Bigmouth	Freshwater	Carp
	Catfish	Buffalo	Drum	
1951	2.9	7.4	1.3	6.2
1952	3.4	8.0	1.4	5.0
1953	3.2	6.5	1.3	6.6
1954	3.0	6.9	1.5	5.5
1955	2.3	6.0	1.1	3.4
1956	2.3	5.0	0.9	3.3
1957	1.9	4.9	1.1	4.5
1958	1.8	5.0	0.9	4.1
Average	2.6	6.2	1.2	4.8

mortality and lack of dominant year-classes; in other species, decreases were caused by fishing.

In 1952, 728 pounds of fish were caught per 100 yards of seine employed in the relatively unexploited waters of Lake Chautauqua, and, even though the fishing effort was greatly increased after 1952, fishermen were still able in 1957 to catch 623 pounds of fish per 100 yards of seine. However, the species composition of the catch changed considerably during this period, as indicated in Table 44. The most important changes in composition were in buffalofishes and gizzard shad. Apparently adult shad occupied the habitat earlier used by the buffalo population, which suffered a higher fishing mortality rate than other species during the program (Table 5). In order to maintain a high yield in the later years, particularly for buffalofishes, commercial fishermen had to nearly double the fishing effort that they had exerted on the lake with seines

Table 44.—Pounds of fish caught and removed from Lake Chautauqua with commercial (bigmouth), freshwater drum, channel catfish, and gizzard shad, are given number of pounds

Year	Yards of Seine Employed (Cumulative)	Carp		Buffalofishes		Freshwater Drum	
		Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch
1951	14,200	22,653	26.8	49,831	58.8	7,797	9.2
1952	23,400	21,436	12.6	107,885	63.3	26,738	15.7
1953	34,500	15,072	17.4	25,115	29.1	30,943	35.8
1954	49,650	49,139	22.1	65,489	29.4	61,163	27.5
1955	56,250	12,819	8.6	46,039	30.8	52,790	35.3
1956	46,080	8,499	6.0	52,359	37.3	27,825	19.8
1957	42,680	58,893	22.1	99,287	37.3	36,281	13.7
1958	43,450	46,673	30.7	39,257	25.9	26,014	17.1
Total or per cent of catch	310,210	235,184	18.5	485,262	38.1	269,551	21.2

°Less than 0.1 per cent of catch.

in 1952. Even though the commercial fishermen had to increase their effort, the fishing continued to remain as a profitable operation for them. We believe that the decline in the commercial fishery was caused by the increased fishing pressure on the lake by round-up fishing and by seining.

Individual wing-net fishing seemed to have little or no effect on the buffalo fishery prior to 1951. We believe that it would have been possible to maintain a population of large buffalo in

Lake Chautauqua if fishing had been limited to individual wing-net fishing. The present study indicates that, because of the great variation in the strength of annual broods, a buffalo population could be overfished within a few years. Restoration of an overexploited population would depend upon one or both of two possibilities: (i) the production of a large brood such as that of 1953, many members of which survived to be recruited into the adult fish population of Lake Chautauqua

Table 45.—Average numbers of fish caught per fisherman-day and pounds removed per acre by anglers each year at Lake Chautauqua, 1950–1959.

Kind of Fish	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Crappies	0.96	2.59	1.51	2.20	2.41	1.53	0.97	1.52	0.50	0.66
Bluegill	0.73	0.68	0.68	0.30	1.18	2.02	2.39	2.11	2.83	2.43
Yellow bass	0.50	0.19	0.23	0.08	0.24	0.28	0.08	0.38	0.16	2.05
Largemouth bass	0.13	0.08	0.10	0.13	0.04	0.22	0.17	0.07	0.14	0.24
Freshwater drum	0.90	0.31	0.41	0.16	0.34	0.26	0.25	0.15	0.20	0.14
Channel catfish	0.11	0.09	0.09	0.06	0.07	0.07	0.08	0.07	0.04	0.06
Other kinds	0.18	0.17	0.23	0.18	0.24	0.28	0.09	0.16	0.69	0.20
Total	3.51	4.11	3.25	3.11	4.52	4.66	4.03	4.46	4.56	5.78
Crappies and bluegill combined	1.69	3.27	2.19	2.50	3.59	3.55	3.36	3.63	3.33	3.09
Estimated pounds per acre removed by anglers	5.0	6.2	6.1	2.6	10.2	6.5	4.4	6.0	4.0	3.7

cial seines in September, 1951–1958. For each of five kinds, carp, buffalofishes (mainly and per cent of total catch. Data for other kinds are combined.

Channel Catfish		Gizzard Shad		Others		Total
Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	Pounds Caught	Per Cent of Catch	
1,353	1.6	2,400	2.8	651	0.8	84,685
4,346	2.5	10,000	5.9	0	..	170,405
3,638	4.2	11,650	13.5	8	•	86,426
13,038	5.8	33,755	15.2	96	•	222,680
9,997	6.7	27,521	18.4	241	0.2	149,407
15,822	11.3	35,660	25.4	236	0.2	140,401
9,584	3.6	61,670	23.2	340	0.1	266,055
2,967	2.0	34,865	23.0	2,019	1.3	151,795
60,745	4.8	217,521	17.1	3,591	0.3	1,271,854

in 1956, and (ii) recruitment of fish from the river.

Effect on Sport Fishing

The best sport fishing at Lake Chautauqua occurred in 1954 (Table 45), when anglers removed 10.2 pounds (estimated) of fish per acre. The poorest fishing was in 1953, when anglers caught only 2.6 pounds (estimated) per acre. Fishing effort was higher in 1959 than in any other year; however, good fishing did not continue throughout the summer, as was indicated by the small number of pounds per acre removed by anglers in that year (Table 45).

Changes in composition of the sport fishery catch were indicated earlier in the section "Population Dynamics." The changes in the sport fish populations were thought to have been natural fluctuations of abundance. The catch per unit of effort (per fisherman-day) was slightly better for most years after 1954 than for most years before. However, the yield in pounds per acre did not increase; it was higher in the period 1950–1954 than in the period 1955–1959. We believe that, at Lake Chautauqua, commercial fishing had no lasting measurable effect on sport fishing.

DISCUSSION

A few old Illinois River fishermen are still left who recall the so-called "good old days" of fishing in the river and its floodplain lakes. Many of the floodplain areas have been drained and now produce corn instead of fish. The old-timers remember how they or their fathers, fishing in the open pockets of the heavy beds of "moss" with long cane poles and tandem spinners, caught bass for the market. They remember that the water was deeper in the lakes during the summer months than it is today.

Quiver Lake, which lies adjacent to Lake Chautauqua, was a popular fishing lake many years ago. Kofoid (1903: 244) studied the biology of Quiver Lake back in the 1890's and recorded the following observations about the vegetation of the lake during that period:

The vegetation is a very important and much more constant factor in the environment of Quiver Lake than it is in that of the river. In its maximum development reached in the summers of 1894 and 1895 it fills . . . the lake from shore to shore with a closely matted growth, the only open places being an interrupted and tortuous channel through which the waters of Quiver Creek . . . make their way to the river. The vegetation in the body of the lake consists in the main of *Ceratophyllum*, with an admixture of *Elodea* and *Potamogeton* toward the margins. Along the east-

ern shore, and toward the upper end of the lake where springy shores and sandy bottom are to be found, the vegetation partakes more of the permanent littoral character. Here rushes, sedges, arrowleaf, and the aquatic *Cruciferae* and *Umbelliferae* appear among the *Potamogetons* and other floating plants. In the northern area, especially along its western shore, where more alluvium is found, water-lilies, pickerel-weed, and the lotus abound, and the *Potamogetons* are more abundant The "wild celery" (*Vallisneria spiralis*) is sparingly present in the channel of the eastern arm of the lake, while in the tributary bottom-lands above are aquatic meadows of wild rice and other water-loving grasses, rushes, and sedges.

In years of higher water . . . , such as the four following 1895, the vegetation differs from that of low-water years more in quantity than in kind. The main body of the lake and a considerable portion of both arms are freed to a greater or less extent from their vegetation, a border of varying width remaining near the shores, and scattered clumps dotting the lake here and there in the broad stretches of open water.

Today Quiver Lake is devoid of aquatic plants. The formerly deep basin of the lake has been filled in with 4- to 8-foot deposits of silt. Turbid water at depths of over 3 feet and a soft, flocculent bottom prevent the establishment of aquatic plants in the lake. Conditions in Quiver Lake are duplicated in many of the other floodplain lakes of the Illinois River; that is, in the past 35 years siltation has greatly changed the ecology of these lakes.

In the late 1930's Bellrose (1941:237-245) became aware of the changes occurring in the waterfowl habitat of the Illinois River valley. He proposed two methods for managing the floodplain lakes for waterfowl. These methods are extremely important here since they relate directly to habitat changes that affect the fishery.

The first of the methods (Method A) that Bellrose (1941:274) proposed contained the following provisions:

The water levels should be lowered sufficiently by July 1 to leave at least 30 per cent of the area in mud flats, allowing such moist-soil plants as nutgrasses, water hemp or pigweed, various smartweeds, teal grass, wild and Japanese millets and rice cut-grass—all good duck food plants—to develop on the mud flats. These plants usually appear by natural means, without the necessity of sowing. However, if they have not occurred on

the grounds in a number of years, it is advisable to sow the mud flats with Japanese millet seed and tubers of chufa. Chufa might well replace other less valuable nutgrasses, which produce no tubers and which are the more abundant of the species in the Illinois River valley.

In order to make the seeds, tubers or rootstocks of the moist-soil plants available to waterfowl, it is necessary to flood the beds in the fall months. Springs, streams, pumps and natural rises in the Illinois River are used in conjunction with dams . . . and levees to flood such areas.

The second method (Method B) that Bellrose (1941:274-275) proposed included the following:

Water levels should be maintained as nearly constant as possible at a depth of 2 to 3 feet. This creates a habitat suitable for such submerged and floating aquatic plants as long-leaf, sago and bushy pondweeds and coontail. As a result of the water level created by the Peoria navigation dam, bodies of water between Peoria and Henry appear to be best adapted to this type of management.

According to Bellrose (personal communication, July 9, 1963), since 1941, siltation has occurred to such an extent that most Illinois River valley lakes have undergone serious deterioration as aquatic plant habitats. The bottoms of these lakes have become increasingly flocculent and soft, so that important duck food plants, such as coontail, long-leaf pondweed, bushy pondweed (*Najas guadalupensis*), and wild celery (*Vallisneria spiralis*), can no longer, in the presence of wave action, remain attached to the bottom. Moreover, turbidity from wave action reduces the penetration of sunlight to such a degree that plants cannot thrive. Sago pondweed is able to attach itself to the soft bottom in the silt-laden lakes, provided the water level is stable and the water depth is not much more than 3 feet, as is the case in many parts of Lake Chautauqua. Low & Bellrose (1944:10, 14) found that in the Illinois River valley sago pondweed yielded only 10.6 cc of seed per square meter in 1941 and 1942 and that it ranked only 24th in seed production among the aquatic plants in those lakes. Bellrose does not now recommend management Method B in a lake that does not have a firm bottom.

Bellrose's Method A is the most effective technique used today in the Illinois River valley for managing a floodplain lake for the benefit of ducks. If the Illinois River does not overflow and flood the river basin during the summer months, an excellent stand of food plants for ducks is almost certain to develop in the basin by fall. Since the basins of most of the floodplain lakes of the Illinois River valley have become filled in with silt until they are nearly level, the type of drawdown called for under Bellrose's Method A exposes much of the lake bottom to the air. The remaining water is too shallow for the survival of sport fishes. We believe that effective management of an Illinois River floodplain lake for both ducks and fish is virtually impossible.

From 1950 through 1959, Lake Chautauqua was primarily managed under Bellrose's Method B, whereby the water was held as nearly as possible at a stable depth of 2 to 3 feet (435.0 feet above mean sea level). In those years, production of duck food plants was limited largely to sago pondweed, for reasons given above. In early fall, the sago pondweed, when present (1953, 1956, and 1959), was used principally by baldpates (*Anas americana*). Some blue-winged teals (*Anas discors*) and coots (*Fulica americana*) also fed on sago in early fall. By the time the large flight of mallards (*Anas platyrhynchos*) arrived in late October and November, the sago was gone, except for scattered seeds on the lake bottom.

Because of siltation, the basin of Lake Chautauqua is now so nearly level that use of the Method A management plan would be possible in years of low water levels. This plan would involve draining much of the lake basin during the summer to permit the growth (on exposed areas) of moist-soil plants: planted Japanese millet and volunteer native plants. In the autumn, the lake basin would be reflooded by water pumped from the river and diverted from Quiver Creek, or, in some years,

by natural flooding from the Illinois River. If Method A were used, the lake would have very limited use for fish; in the opinion of Frank C. Bellrose of the Illinois Natural History Survey (personal communication May 14, 1964), the lake would have increased value for ducks.

If the lake were to be managed for fish, the summer water level should be equivalent to the 1950 level of 435.0 feet or slightly higher so that most of the lake would be 2 to 4 feet deep. Sedimentation surveys at 10-year intervals would show the extent of storage loss for each decade and allow a revision of the base level to compensate for the loss in storage. The river should be permitted to flow into the lake at a level of 437.5 feet or slightly higher.

In the years of our study, the density-independent factor that includes all phenomena associated with or influenced by stable or varying water levels was considered to be the single most important factor affecting the dynamics of the fish populations of Lake Chautauqua. In our opinion, if the river were kept out of the lake, and the water could be held at a normal pool level for a period of about 5 years, the populations of some of the fishes would become overabundant and the yield of both the sport and commercial fishes would decline. For nearly 40 years, the senior author has been somewhat familiar with the fishing at Spring Lake (Tazewell County), near Lake Chautauqua. Since Spring Lake was isolated from the Illinois River in about 1910, it has produced mainly small sunfish. According to old-timers, prior to 1910 the fishing in Spring Lake was excellent, and the fish were of sizes attractive to fishermen.

Many facets of fish population dynamics involved with fluctuations of water levels in river and lake and with connections between river and lake are not clearly understood. However, the good growth rates and the apparent lack of overpopulation of the fishes in

Lake Chautauqua during the period of our study made us realize that the density-independent factor, water levels, was probably the principal factor acting upon the fish population of this floodplain lake. Lack of regularity of fluctuations was characteristic of Lake Chautauqua during our investigation. In one year, high water came in May and the following year it came in June and July. In another year, water was low and stable throughout the entire growing season. The water levels affected such diverse needs of fish as food, cover, space, and spawning. Stable water levels favored the growth of sago pondweed, which provided cover for the fish and growing space for the periphyton on which many fish fed. Fluctuating water levels undoubtedly had an important effect upon the spawning success of some fish species. For example, several nests of largemouth bass were found stranded by a 1-foot drop in water level. Possibly in some years large numbers of carp eggs were destroyed by receding waters. Richardson (1913:402-403) recorded the destruction of large numbers of carp fry as a result of the drying up of spawning grounds near Havana. The largest broods of carp and bigmouth buffalo produced in Lake Chautauqua during the course of our study occurred in 1953, a year of low and stable water levels during late spring and summer; however, when similar water level conditions existed in 1956, no large survival of spawns of carp and bigmouth buffalo occurred.

Because, during periods of high water, fish could enter or leave Lake Chautauqua, possibly the sizes of some fish populations were changed during such periods. We found some evidence that carp and gizzard shad made population adjustments in periods of high water.

The influx of biogenic salts into Lake Chautauqua from the Illinois River was not measured in the period of our study, but probably the river con-

tributed such nutrients to the lake. Waterfowl contributed nutrients in the form of excreta. The exposure and reflooding of portions of the lake bottom undoubtedly were beneficial in making certain nutrients available. At normal pool stage, most of the lake water was within the calculated euphotic zone, which represented depths of 41.0 to 53.5 inches in the growing season of 1953 (Jackson & Starrett 1959:159). In such a situation, the growth of bottom microflora, which served as food for macrobenthic organisms and fish, was possibly stimulated.

Stroud (1948:93-94) concluded from his studies at Norris Reservoir, Tennessee, that "The present long-term cycle of water-level fluctuation is beneficial to the fish population as a whole resulting, as it apparently does, in periodic increases in the food supply and subsequent improvement in growth rates." Wood (1951), Bennett (1954*b*), Hulsey (1957), and others have considered water levels as an important factor affecting fish populations.

The commercial seine hauls made in Lake Chautauqua in September of each year, 1951-1958, were at approximately the same water levels. In years of low water levels during the growing season, sago pondweed was abundant and in such years crappies and bluegills were taken in considerable numbers in the seine hauls. In years of high water levels during the growing season, sago pondweed was either sparse or absent, and only a few crappies and bluegills were caught in the commercial seines. We have concluded from the seining and netting operations that in seasons in which sago pondweed was sparse or absent the crappie and bluegill populations were concentrated in the stump-filled semipermanent shoreline habitats, while in seasons in which sago flourished crappies and bluegills were widely distributed. We believe that the density-independent factor, water levels, actually changed the carrying capacity of the lake through bringing

about changes in turbidity, food supply, vegetation, and suitable space.

We believe that the commercial fish removal program in Lake Chautauqua in the years of our study might have had a measurable effect upon the sport fishery had it not been for the fluctuating water levels, successful reproduction of fishes in the lake, and recruitment of fishes from the Illinois River.

We believe that the principal benefit resulting from the increased fish removal program at Lake Chautauqua was in the economic gains to the participating commercial fishermen and in the utilization of the fish as food for man, food that otherwise would have been lost.

SUMMARY

1.—Lake Chautauqua is located near Havana, in Mason County, Illinois. It is a restored 3,562-acre lateral-levee reservoir, shallow and subject to flooding by the Illinois River.

2.—A biological investigation was conducted on the fishes of this lake over a 10-year period, 1950–1959. The present paper is concerned principally with the various fishes and their relative abundance in Lake Chautauqua, their biology, the dynamics of their populations, and the effects of commercial fishing on them. Sedimentation, turbidity, chemical, and bottom fauna studies were made in conjunction with the fishery investigation.

3.—Field data were obtained on the fishery by creel censusing, commercial wing-net fishing, commercial seining, test-net fishing (1-inch-square-mesh wing nets), minnow seining, use of rotenone, and electrofishing. During the investigation, 52,214 fish were weighed and measured. In addition, 12,814 small fish were measured; 23,812 fish were aged.

4.—Prior to 1951, fishing pressure on the lake was comparatively light. Up to that year, commercial fishing was restricted to the use of individual wing nets. The estimated annual yield from

the lake (all fishes) in the period 1942–1949 ranged from 12 to 45 pounds per acre (48.4 pounds per acre in 1950). To increase the yield, supervised commercial seining was carried on at the lake in September of each year, 1951–1958. Roundup fishing with wing nets, started at the lake in 1952, helped to increase the yield. In the 1951–1958 period, the annual yield of all fishes ranged from 73.1 to 121.0 pounds per acre. During the 10-year period of the study, 2,991,131 pounds or 839.7 pounds per acre were removed. Buffalofishes (mainly bigmouth buffalo) comprised 49.1 per cent of the weight of fishes removed from the lake.

5.—Sixty-four species of fish were collected from the lake. At least 30 of these species were either rare or rare-occasional, 21 species ranged from occasional to common, and only 13 species occurred abundantly. The abundant species were bigmouth buffalo, gizzard shad, carp, freshwater drum, bluegill, white crappie, black crappie, yellow bass, channel catfish, shortnose gar, emerald shiner, spottail shiner, and brook silverside.

6.—The growth rates of 14 species of fish at Lake Chautauqua were determined. Growth rates of most of the species studied compared favorably with growth rates of these species in other waters. A few species had excellent growth rates. Lack of stunted fish indicated that the fish populations in the lake were not overcrowded. In some species, the population was dominated for several years by one or two year-classes.

7.—Most of the catch of freshwater drum in the commercial seine hauls was composed of 3-, 4-, and 5-year-old fish. Very few drum in the catch were more than 6 years old.

8.—During the investigation, only two dominant year-classes of adult bigmouth buffalo were observed, those of 1948 and 1953. The increased removal of bigmouth buffalo changed the buffalo population in 4 years from one con-

taining a high percentage of old, large fish to one of predominantly young, small fish.

9.—One large carp spawn was observed during the study, that of 1953. Apparently, after September, 1956, carp were recruited into the lake from the river.

10.—Five-year-old and older fish dominated the catch of channel catfish in the commercial seine hauls in 1953 and 1954. After 1954, the commercial fishery of this species was dependent mainly upon 4-year-olds. Apparently, the change in this fishery was caused by the increased removal of catfish.

11.—The bluegill population in most years of the study was composed of several broods, of which one brood had better representation than the others. The minnow seine hauls indicated that bluegills spawned with varying degrees of success; the success of several year-classes of bluegills varied considerably in later life. Apparently, many of the fish of a large and dominant brood of bluegills died from natural causes during their sixth summer of life (as 5-year-old fish).

12.—One large and dominant brood of white crappies was observed during the study. Natural mortality of white crappies was high in the fourth summer of life (as 3-year-old fish). In most years, black crappies were less abundant than white crappies.

13.—The strength of the year-classes of yellow bass observed during the study varied considerably.

14.—Only two year-classes of white bass observed in the lake during the study were of even moderate size. Tagging studies indicated that a large percentage of white bass over 1 year old moved out of the lake in periods of high water.

15.—Controlled commercial seining appeared to be the best method available to obtain population data on the abundant large fish in the lake. Population analysis was based on 348 completed seine hauls. Large variations oc-

curred in catch from haul to haul. These variations were believed to have been related to (i) uneven distribution or concentration of fishes in the lake, (ii) movement of fishes within the lake, and (iii) accidental loss of fish from the seines. Tremendous variations in catch occurred among the seine hauls made in a given section of the lake (three sections). Statistical analysis indicated that impractical numbers of seine hauls were required to detect 10 per cent changes in population of the most numerous fish species. In the study, enough hauls were made to detect 40 to 50 per cent changes in the populations of buffalofishes, drum, and channel catfish, but only more drastic changes in the populations of carp.

16.—After the areas covered in seine hauls were found to be roughly circular, calculations were made of the number of pounds of fish caught per acre seined.

17.—Data from both tagging and test-netting were used in estimating the size of crappie populations.

18.—The standing crop of all species of fish at Lake Chautauqua was estimated to be about 500 pounds per acre in the 1951–1952 period. In 1957, the estimated standing crop of usable-size fish of four commercial kinds and gizzard shad was not far below the 1951–1952 estimate for these species. However, the species composition had changed. Populations of shad and of undersized carp had increased in size since the earlier period.

19.—The population of freshwater drum showed a downward trend after 1954. This trend was apparently associated with increased removal of drum and the scarcity of members of two year-classes.

20.—In 1955, the percentage of large channel catfish (fish of 20 inches or more total length) taken in the seine hauls dropped considerably; the catch showed an increase in the number of 3- and 4-year-old fish. In 1958, a sharp decline occurred in the catch of catfish;

the decline was believed caused by the small size of the 1955 brood and by heavy removal in previous years of 4-year-old and older fish.

21.—Increased fishing pressure on the lake reduced the size (weight) of the bigmouth buffalo population below the size of the population of 1951–1952. The bigmouth buffalo population in the 1951–1952 period was composed mainly of members of the large 1948 year-class and a considerable number of older fish; the population in 1957 was dominated by the large 1953 year-class and contained very few older fish.

22.—The catch of gizzard shad per estimated acre seined in the 1951–1952 period was 19.7 pounds, whereas in 1957 the catch was 88.5 pounds per acre seined. Increases in the shad population appeared to be associated with decreases in the bigmouth buffalo population.

23.—Twenty-one years of creel-census data indicated that the adult populations of crappies (both species), bluegills, and yellow bass in Lake Chautauqua fluctuated widely.

24.—At the end of 4 or 5 years of the investigation, improvements in the growth and condition of bluegills, crappies, freshwater drum, and bigmouth buffalo could have been correlated with the increased removal of commercial fishes. When the investigation was continued, the early improvements apparently were lost. Successful reproduction, recruitment of fish from the

river, and water levels tended to offset any measureable benefits resulting from the increased removal of fish.

25.—Water levels were considered as a density-independent factor affecting the condition and growth of bluegills, crappies, and possibly certain other species.

26.—After 1953, the average fall condition factors of carp and drum followed rather similar downward trends. Other species of fish studied did not follow such trends in condition. The declines in condition of carp and drum may have been related to the scarcity of fingernail clams in the lake after 1953.

27.—In the past 35 years, siltation has greatly changed the ecology of many of the floodplain lakes of the Illinois River. For management of the fishery, sedimentation surveys of Lake Chautauqua should be made every 10 years and the summer pool stage of the lake increased to compensate for any loss of storage capacity caused by siltation.

28.—The density-independent factor, water levels, was probably the single most important factor affecting the dynamics of the fish population of Lake Chautauqua.

29.—The principal benefit resulting from the increased fish-removal program at Lake Chautauqua was in economic gains to the participating commercial fishermen and in the utilization of the fish as food for man, food that otherwise would have been lost.

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INDEX

Page numbers in italic type indicate principal references. Fish species having names of more than one word are listed with the words in normal rather than inverted order: for example, *Bigmouth buffalo* rather than *Buffalo, bigmouth*. Cross references are given only if believed necessary. Because *Angler(s)*, *Anglers' catch(es)*, and *Angling* are in close proximity in the index, no reference from one to the other is given; however, after *Angler(s)*, reference is given to *sport fishermen*.

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Stocking and Sport Fishing at Lake Glendale (Illinois)

DONALD F. HANSEN

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Bulletin

Volume 29, Article 2
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This report is printed by authority of the State of Illinois, IRS Ch. 127, Par. 58.12. It is a contribution from the Section of Aquatic Biology of the Illinois Natural History Survey.



Stocking and Sport Fishing at Lake Glendale (Illinois)

DONALD F. HANSEN

PROBABLY most fisheries biologists in the United States would agree that good fishing in new impoundments depends to a considerable extent on the species, sizes, and numbers of fish used in the stocking and also on the time or times of the year that the introductions are made. Fairly dependable stocking procedures have been developed for ponds of 1 or 2 acres; however, little experimentation has been done to find equally dependable procedures for stocking large lakes or reservoirs. The possibility of contamination with unwanted species, the large numbers of fish needed to carry out some stocking plans, and the expense of carefully evaluating stocking results are the principal drawbacks to stocking experiments in large impoundments.

In April, 1940, the Illinois Natural History Survey stocked two newly built recreation reservoirs in southern Illinois, Lake Glendale (82 acres) in Pope County and Pounds Lake (33 acres) in Gallatin County, with largemouth bass, *Micropterus salmoides* (Lacépède), and bluegills, *Lepomis macrochirus* Rafinesque.

This combination of fishes, which had recently been introduced by Swingle & Smith (1938:2) for small ponds in Alabama, soon became a popular combination for ponds in various other parts of the United States. The purpose of the bass-bluegill stocking at Lake Glendale and Pounds Lake was to determine the value of this combination for lakes of moderate size in Illinois.

Because the bass fishing that fol-

lowed the 1940 stocking at Lake Glendale was disappointing to anglers, fish of all kinds were removed in a draining-rotenoning census operation in the fall of 1946, and the lake was restocked, again with bass and bluegills but at different rates and with fish of different sizes than were used initially. Swingle & Smith (1938:2 and 1942:13) had recommended stocking ponds with comparatively large numbers of fry or fingerling fish; one recommendation for unfertilized ponds was 400 bluegills (bream) and 30 bass per acre. Both Glendale and Pounds had been stocked with comparatively small numbers of adult bass and bluegills in 1940; Glendale was restocked with a mixture of adult and yearling bass and bluegills in 1946. The 1946 Glendale stocking was considerably heavier in number of fish per acre than the 1940 stocking of the two lakes. Bass fishing at Lake Glendale showed great improvement in the second summer after the 1946 stocking, but the improvement did not hold up. In the fall of 1950, the lake was almost completely drained (frontispiece), the bass population was censused, and large numbers of bass were removed. The evaluation of angling that followed the 1946 stocking is concluded with the 1950 fishing season.

Various bass-bluegill stocking procedures employing fry or fingerlings, adult fish alone, or mixtures of adults and fingerlings have been evaluated by Surber (1949), Swingle (1951), and Smith, Kirkwood, & Hall (1955). In these studies, stocking success was

Frontispiece.—The Lake Glendale basin after the October, 1950, draining. The mainstream channel and tributary channels are plainly visible. Beds of rooted aquatic vegetation are seen as dark bands running approximately parallel with the lake margin. Water can be seen in the lower half of the mainstream channel; also, in a small area of the lake bottom near the dam, and in a small pool to the right of the beach (the beach is the large light area near the dam).

measured in such terms as standing crops of young and adult fish, balance of bass and bluegills, or evidence of overpopulation of one or both species. The principal basis for evaluation of the stocking procedures at Lake Glendale was the quality of the hook-and-line fishing.

Neither of the stocking procedures used in the present study was among those reported by other workers. The 1940 stocking rates for adult largemouth bass and bluegills were almost the same as the rates used by the Illinois Department of Conservation when it provides adult fish for large publicly-owned waters. For this reason, the results of the present study have special significance in this state.

ACKNOWLEDGMENTS

The following employees of the U.S. Forest Service in the Shawnee National Forest of southern Illinois co-operated in the study reported here: Arlie W. Toole, Roy N. Olson, and E. N. Lee, Forest Supervisors; Wilfred James, District Ranger; and J. T. Turner, Forestry Technician.

The hook-and-line catch was recorded by various operators of the Lake Glendale concession: Louis H. Walker, R. B. Veach, and Mr. and Mrs. Roy W. Schoettle and their employees.

Jacob H. Lemm, Melvin T. Huish, Quentin Pickering, and Wallace Hart, employed by the Illinois Natural History Survey, and Ray Brown, Guy Bellamy, William Davidson, Leonard Deevers, Paul Smith, John Savage, Ralph Guthrie, Roy Cox, Bruce Muench, and Truman Dick, employed by the State Department of Conservation, helped with the census operations either in 1946 or 1950.

The following men were employed by the Natural History Survey as test fishermen at Lake Glendale: Harry K. Phinney in 1944, Melvin T. Huish in 1945 and 1946, Charles S. Stubbs in 1947, and Maurice G. Kellogg in 1948, 1949, and 1950.

The annual fish harvests for the early years of the study were totaled by Elizabeth Brown Chase and for the later years by the University of Illinois Statistical Service.

Esden Jerrels, concessionaire, and his assistant, Arland Black, collected the data on fishing at Pounds Lake in the period 1943-1946.

Many helpful criticisms of the manuscript have been made by George W. Bennett and R. Weldon Larimore of the Illinois Natural History Survey's Section of Aquatic Biology. James S. Ayars, Technical Editor of the Survey, 1937-1965, edited the manuscript.

Illustrative material was provided by the following persons: Charles L. Scott, formerly photographer of the Illinois Natural History Survey, for the frontispiece and for Fig. 2 and 5; J. B. Stall of the Illinois Water Survey and R. B. Collier of the U.S. Geological Survey for Fig. 1; Joe Dexter of Robbs, Illinois, for Fig. 3; James S. Ayars for Fig. 6, 8, and 9; and William L. Taylor, draftsman of the Illinois Natural History Survey, for Fig. 7.

LAKE GLENDALE

Lake Glendale, which lies within the U.S. Forest Service Glendale Recreation Area in the Shawnee National Forest, is an artificial lake of 82 acres located 2 miles north of Dixon Springs in Pope County, southeastern Illinois. The dam for the lake was completed in the fall of 1939, and the basin filled with water during that winter and the following spring. In addition to fishing, the Glendale Recreation Area offers camping, picnicking, swimming, and rowboating.

The Lake Glendale watershed consists of 1,400 acres of forest or abandoned farmland. Water enters the lake from a temporary stream at the east end and from numerous well-vegetated gulleys on the north and south sides. The lake is 0.8 mile long and 0.2 mile wide at the widest point (exclusive of bays) and it has a shoreline of 3.2

miles. When the lake is at full stage, the maximum depth (near the dam) is 22 feet, if measured at the top of the original stream bank, or 24 to 25 feet, if measured at the middle of the channel (contour map, Fig. 1). The average depth of the lake is 10.9 feet. The contour map shows that the lake bottom slopes more steeply along the south shore than along most of the north shore. The shoreline is marked by numerous bays. A large part of the lake bottom was under cultivation up to the time the dam was built.

In most years during the 1940's, the water was turbid from March into May but relatively clear through the summer months. In 1944, for example, a secchi disc could be seen to a depth of 12 inches in March, 3 feet in early July, and 7 feet in mid-July. The high transparency of the water in the summer months was presumed to be related to the nearly complete suspension of farming on the 1,400-acre Lake Glendale watershed. By 1946, silt had been deposited to a depth of about an inch over most of the lake bed. In the area close to the mouth of the main tributary stream (an area comprising several acres), and at least in the lower third of the original stream channel, the accumulated silt had reached a depth of about a foot.

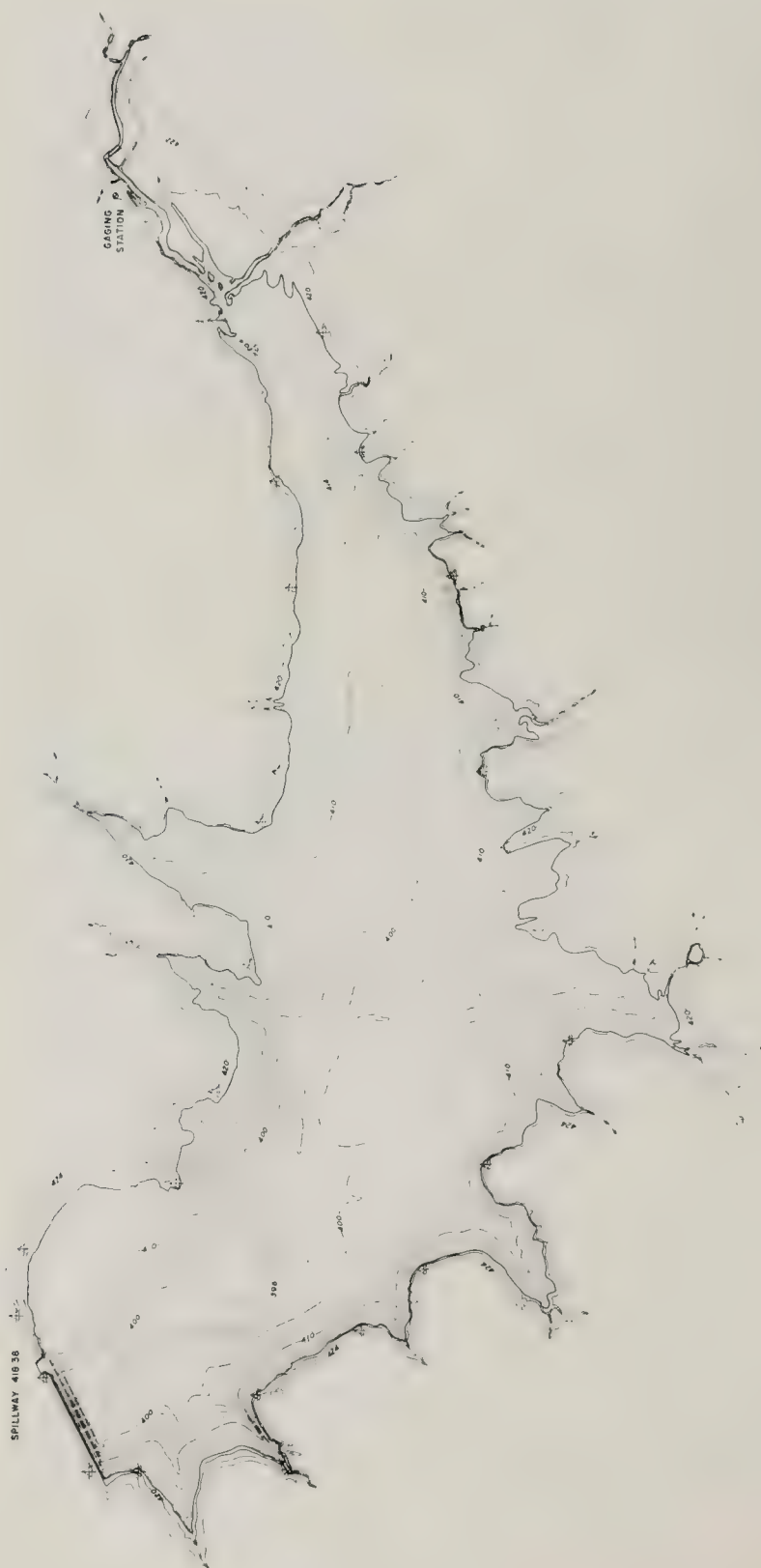
In midsummer during the years of this study, the upper layer of warm water, the epilimnion, extended from the surface to depths of 8 to 12 feet, the depth depending on air temperatures and the amount of mixing by recent winds.

Compared with most lake waters in northern and central Illinois, the water in Lake Glendale is extremely soft. A water sample collected from the lake in April, 1944, had a total hardness of only 27 parts per million. This is similar to the hardness of the water in six small farm ponds in the neighborhood (Hansen et al. 1960:350).

Although the loess forest soils in Pope County are relatively poor for

agriculture (compared with loess soils in most parts of Illinois), they can be farmed profitably if they are properly treated. The minimum treatment recommended by agronomists consists of periodic applications of ground limestone and of phosphorus fertilizer. On some Pope County farms, complete fertilizers are regularly used in addition to the limestone and phosphorus fertilizer. R. J. Webb, Superintendent of the University of Illinois Dixon Springs Agricultural Center, which adjoins the Glendale Recreation Area, is of the opinion that these materials have probably been used on only a small percentage of the land draining into Lake Glendale. The lake water has never been fertilized.

The following description of the aquatic plant distribution in Lake Glendale is based on a detailed map prepared by Harry K. Phinney when he worked for the Illinois Natural History Survey during the summer of 1944. Plant distribution in that year was typical for most of the period covered by the present study, that is, 1942-1950. Cattails, *Typha latifolia* Linnaeus (Fig. 2), which later almost disappeared from the lake, formed a nearly continuous fringe around the lake margin, growing from the water's edge to a depth of 3 to 3.5 feet. From the outer edge of the cattails to a depth of about 10 feet the bottom was almost covered with *Chara* sp. American lotus, *Nelumbo lutea* (Willdenow) Persoon, grew thickly in the largest bay on the north side but nowhere else on the lake. Small beds of the yellow water lily, *Nuphar advena* (Aiton) Aiton f., grew in the shallow water at the east end of the lake and in most of the bays. Patches of *Potamogeton illinoensis* Morong, some as much as 150 feet across, grew in shallow water in all parts of the lake (the plant later became scarce). The narrow-leaved pondweed, *Potamogeton foliosus* Rafinesque, which was a serious nuisance to swimmers and fishermen in the shal-



LAKE GLENDALE, ILLINOIS

Under water contours from soundings
by J. B. Stait - ILL. Water Survey

Topography by: R. B. Collier
1956

Fig. 1.—Contour map of Lake Glendale and shoreline. Elevations are shown in feet above sea level. The spillway is 418.38 feet above sea level.
(Scale: 1"=600 feet.)



Fig. 2.—Cattail and willow border at Lake Glendale. Much of the shoreline looked like this in the 1940's and early 1950's.

low parts of the lake in 1954, was restricted to a few small patches in 1944. Several other plants, including arrowhead (*Sagittaria* sp.), sedge (*Carex* sp.), sweet flag (*Acorus calamus* Linnaeus), and wild rice (*Zizania aquatica* Linnaeus), were quite scattered, and stands were generally small. Willow trees, *Salix* sp., grew close to the water's edge along most of the shoreline.

STUDY PROCEDURES AT LAKE GLENDALE

In both 1940 and 1946, the intention was to limit the fish stock in Lake Glendale to two species, the largemouth bass and the bluegill. However, in spite of attempts to eliminate fish from the feeder stream by rotenone applications before the 1940 stocking, the stock became contaminated by other species, principally the green sunfish, *Lepomis cyanellus* Rafinesque, and the war-

mouth, *Chaenobryttus gulosus* (Cuvier); both the green sunfish and the warmouth survived the drawdown and the rotenone treatment that preceded the 1946 stocking.

The 1940 Stocking

The original release of fish in Lake Glendale was made on April 8, 1940, with bass and bluegills taken from Lake Chautauqua, near Havana (central Illinois). Included in the stock used were the following fish, all adults:

- 70 largemouth bass, 10–14 inches total length (0.9 fish per acre)
- 215 bluegills, 4–7 inches total length (2.6 fish per acre)

Some of the bluegills were weak when released in the lake, probably as a consequence of having been held for several days in a live box before being transported in a tank to Lake Glendale. The extent of mortality among these

fish was not determined. The bass, although kept in the live box with the bluegills and transported with them, appeared to be lively and in excellent physical condition.

Seine and fyke net catches made at Lake Glendale in the spring of 1941 showed that bass, bluegills, and green sunfish (the green sunfish were probably survivors from the stream population) had reproduced successfully in 1940.

In September, 1941, about a year and a half after the original stocking, a Department of Conservation fish rescue crew released in Lake Glendale a load of several hundred fish that had been seined from a nearby pond. A Department of Conservation law enforcement officer who was present when the fish were unloaded at the lake reported that many of these fish were weak and dying when they arrived. This officer did not count the fish but he estimated that the load had included the following:

- 275 largemouth bass (35 about 10 inches long, the rest smaller)
- 500 bluegills
- 100 warmouths and green sunfish
- 12 black bullheads, *Ictalurus melas* (Rafinesque)

Since adult bass, bluegills, and green sunfish had been present through two spawning seasons, and all three species had reproduced successfully by the summer of 1941, this load of fish probably had no significant effect on the populations of the three species. However, it may have been the cause of the establishment of two species, neither of which became very important, namely the black bullhead and the warmouth. The bullheads reproduced poorly, if at all; only 9 bullheads were reported caught by fishermen in the period 1942-1946, and only 14 bullheads were found when the fish population was censused in 1946. Only 237 warmouths were caught during the 1946 fishing season (compared to more

than 5,000 bluegills) and only about 2,300 warmouths were recovered in the 1946 census.

In June, 1940, the mosquitofish, *Gambusia affinis* (Baird & Girard), was introduced by workers or, more likely, by the staff of the nearby Civilian Conservation Corps work camp at Eddyville, 9 miles away. The small numbers of fish of other species found when the population was censused in 1946—1 longear sunfish, *Lepomis megalotis* (Rafinesque), 5 carp, *Cyprinus carpio* Linnaeus, and 17 golden shiners, *Notemigonus crysoleucas* (Mitchill)—had unknown origins; they may have been introduced by fishermen using live minnows during the 1943 fishing season, the only season in which minnow fishing was allowed.

The 1946 Stocking

The second stocking, which was quite different from the first in terms of numbers and sizes of fish used, was made late in November, 1946, with fish from Lake Glendale which had been stored in a farm pond at the time of the draining operation. The 1946 stocking was much heavier than the 1940 stocking and included young-of-the-year as well as adult bass and bluegills. About one-third as many bass and one-twelfth as many bluegills were returned to the lake as the number of individuals (more than 2 inches in length) counted in the census. Approximately 66 per cent of the bass and 92 per cent of the bluegills had been killed with rotenone in the population census.

The numbers of largemouth bass and bluegills used in the 1946 stocking and their approximate total lengths were as follows:

Largemouth bass	
828—3-5.5 inches total length	
1,397—6-11 inches total length	
23—17 inches total length and larger	
Total 2,248	(27.4 fish per acre)

Bluegills
613—2-3.5 inches total length
2,776—4-7.5 inches total length
Total 3,389 (41.3 fish per acre)

The bass and bluegills in this stocking were not measured individually but were counted according to easily recognized size categories. Approximately 140 of the bass measured 10 inches or longer and approximately 2,400 of the bluegills measured 6 inches or longer. The weight of the 2,248 bass was the same as that of the 3,389 bluegills, namely, 584 pounds, or 7 pounds per acre.

Although the small quantity of water that remained in the lake bed following the 1946 draining was heavily treated with rotenone to complete the fish census, as described in the section "Population Censuses," a number of warmouths and green sunfish managed to survive. Thus, the 1946 stock of bass and bluegills was contaminated just as the 1940 stock had been contaminated.

Creel Census

A creel census was started at Lake Glendale when the lake was opened to public fishing in May, 1942. It was intended to cover all of the fishing done at the lake. The Lake Glendale concession stand, which was headquarters for boat rentals, was used as the creel-census station. Each sport fisherman, at the beginning of his day's trip, obtained a fishing permit from the creel-census station. At the end of the day's fishing, he reported his results to a station attendant, who recorded the results on a special report form. The state fishing license of each fisherman required to have a license (persons of 18 years and older) was held at the census station during the trip as assurance that results of the trip would be reported.

During the first year of fishing (1942), the information recorded on the report form of each fisherman included the following:

- Name and address of the fisherman
- Number and aggregate weight, by species, of all fish kept
- Estimated number, by species, of all fish caught and thrown back in the water

Beginning in 1943 and continuing through 1950, the following additional information was obtained:

- Starting and stopping times of each fishing trip
- Types of bait used—such as plugs, flies, worms
- Whether fishing was done from a boat or from shore
- Whether the fisherman had a state fishing license or was too young to need one

Fishing Regulations

The state fish code during the years 1942-1950 allowed each fisherman to keep 50 bluegills and 10 bass a day and provided for a 10-inch length limit on bass but no length limit on bluegills. Fishing with live minnows was allowed at Lake Glendale only during the 1943 season. The fishing day was limited to the approximate hours of 6 AM to 9 PM Central Standard Time.

The length of the fishing season at Lake Glendale varied somewhat from year to year. The usual opening date corresponded with the opening date of the largemouth bass season in southern Illinois, May 15. The regular season ended with the closing of the concession stand at the lake, the dates varying from September 1 to September 20. Closing dates were determined mainly by weather. Special seasons were set up by the Natural History Survey in 1943 and 1946: in 1943, fishing was allowed each Sunday throughout September, October, and November, and in 1946, fishing was allowed on the five Sundays preceding the regular May 15 opening. Fishermen were allowed to keep largemouth bass as well

as other species during the special 1943 and 1946 seasons. This report includes fish caught during the two special seasons.

The fishing regulations that applied to Lake Glendale were posted on the road leading to the lake from State Highway 145, at the two picnic areas, at the concession stand, and at the boat dock. In spite of the posted regulations, a certain amount of fishing—possibly 5 to 15 per cent of the total—was unreported each year. Some of this was shore fishing from the picnic areas, most of it by people who failed to read the signs. Some fishing was done at night after the closing hour for the creel-census station, and some was done outside the regular season. Possibly some of the fishermen who reported zero catches did not actually leave empty handed. Harvest figures reported here are therefore too low, but it is not believed that the unreported fishing had any serious effect on computed catch rates (catch per trip) or that it invalidated the comparisons of the two stocking efforts.

Length Measurements

In the summer of 1942, Natural History Survey employees measured and recorded lengths of 22 per cent of the bass kept by sportsmen; most of these length measurements were made on May 15, the opening day of the fishing season. No length measurements were made in 1943. In the summers of 1944–1950, Survey employees hired as test fishermen (one each summer) recorded lengths and weights of all kinds and all sizes of fish which they themselves caught during their test fishing trips. The test fisherman on duty in 1944 measured 66 per cent of the bass catch for the year. He measured bass on Sundays from early June through early September. Census clerks (concession stand employees) recorded the lengths of most of the bass kept by sportsmen in the years 1947–1950, but did not record the lengths of other

species; their length data included 87 to 96 per cent of the bass harvested by sportsmen in the years 1947, 1949, and 1950 and slightly more than half of the bass harvested in 1948.

Fish lengths (total lengths) were measured to the closest 0.1 inch and grouped into half-inch classes for showing length distribution. For example, the 12-inch class includes fish that measured 11.8 to 12.2 inches and the 12.5-inch class fish that measured 12.3 to 12.7 inches.

Population Censuses

In the two censuses of fish populations at Lake Glendale (the first, in 1946, a census of all species present and the second, in 1950, a census of only the largemouth bass), water was let out of the lake through a drain valve into a dewatering ditch below the dam.

To stop the fish coming through the valve, two screens were installed side by side in slotted concrete pillars about 200 feet below the dam (Fig. 3). The screens were made of 1-inch-mesh poultry netting stretched across frames made of 1.5-inch angle iron, each frame 8 feet long and 2.5 feet high. When small fish began coming through the drain valve they were stopped by placing hardware cloth screens (0.25-inch mesh) over the poultry netting. Planks placed in the slotted pillars in front of each screen raised the water level on the upstream side of the screens to form a seining pool, about 2 feet deep, from which fish were collected.

In 1946, fish remaining in the lake basin were collected and counted after they had been killed with rotenone. In 1950, an estimate of the number of bass remaining in the basin was made by the mark-and-recovery method.

THE 1946 CENSUS OF ALL SPECIES.—Draining of Lake Glendale in 1946 was begun on October 4 and completed October 31.

When leaves that had fallen from nearby trees clogged the 1-inch-mesh screens in the early stages of draining,



Fig. 3.—Weir for collecting fish that moved out of Lake Glendale during the draining operations in 1946 and 1950.

the screens were removed and were not replaced until the level of the lake had been dropped 7 feet. Fish did not begin coming through the drain valve until October 24, when the lake level had fallen 14 feet.

The fish that came through the drain valve were counted, weighed, and then hauled to a nearby farm pond by a crew of five men. This part of the operation required 5 days, October 26–30. The fish were afterward used in restocking the lake.

When as much water as possible had been drained from the lake basin, the larger part of the fish population of 2 inches and longer remained within the basin in a 1,300 foot stretch of the original stream channel (Fig. 4), while small numbers of fish remained in some very small isolated pools in other parts of the basin. The part of the channel where the fish were concentrated was approximately 30 feet wide and had an average depth of about 2

feet. Many of the fish that remained in the channel might have gone out with the drain water if, in the late stages of draining, the water could have been let through the drain valve more rapidly and without interruptions. However, continuous rapid draining was impracticable: (i) because the drain water might have topped the screens, which were partially clogged with leaves, and (ii) because fish would have come through the valve faster than they could have been processed.

Early in the afternoon of November 6, a treatment of 11 pounds of powdered derris (5 per cent rotenone) was applied to the channel and the isolated pools; this was followed by a second treatment of the same waters with 15 pounds of derris on the afternoon of November 8. The volume of water treated was about 2 acre-feet.

A hoop net that was placed in the channel and raised at irregular inter-

vals from October 25 to November 22 (Table 1) showed sharp increases in catches on November 1, following the completion of drainage on October 31 and the confinement of a large part of the fish population in the stream channel. Contributing to the increases may have been accelerated fish activity resulting from severe crowding, extremely high turbidity, and difficulties in locating food. Contributing to still higher catches on November 7 and 8 may have been the rotenone treatment on November 6, a rainstorm and a 3-foot rise in water level on the night of November 6, and a fall in the water level after the drain valve was reopened on November 7.

The indications from Table 1 are that most of the bass and bluegills in

the stream channel were killed by the first rotenone treatment and that the remainder were killed by the second; that large numbers of warmouths and green sunfish survived the first treatment and that some survived the second. That more fish were not killed by the first treatment may have been due to the inflow of storm water on the night of November 6, which diluted the concentration of the rotenone.

The apparent elimination of the bass and bluegills and the survival of warmouths and green sunfish suggested by Table 1 is substantiated by later observations. In March, 1947, 4 months after the lake had been restocked with fin-clipped bass and bluegills, the catch in six nets raised on 3 successive days included 1 fin-clipped bass and



Fig. 4.—Part of the stream channel in the Lake Glendale basin, November 26, 1946. A large part of the fish population remained in the channel after the 1946 and 1950 drainings.

75 fin-clipped bluegills but no bass or bluegills that had not been fin-clipped. The same catch included 2 adult green sunfish that had not been fin-clipped. During the summer of 1947, the Natural History Survey test fishermen caught 8 additional green sunfish that had not been fin-clipped. Six of these were large enough to have been survivors of the rotenone treatments. Other fish caught by the test fishermen in 1947 included 66 adult fin-clipped bass, 2 small bass not fin-clipped (scale examination indicated these were young-of-the-year fish), and 23 fin-clipped bluegills (no bluegills not fin-clipped). No warmouths were taken from the lake in 1947, but they were caught by anglers in 1948 and later.

Since the rate of dosage was much heavier than the 3 pounds of derris per acre-foot commonly used, it is likely that the low water temperatures at the time of the treatments were responsible

for the slow action of the rotenone. It is also likely that low temperatures were responsible for the incomplete kill, and that they contributed to the slow rate at which dead fish bloated and came to the surface of the water. When the hoop net was examined (but not emptied) about 3 hours after the rotenone was applied on November 6, all but a few fish were found to be alive. As is well known, in warm weather large numbers of dead fish are usually seen at the surface within an hour after rotenone is applied. A few dead bluegills 1 inch long were seen in the channel on November 6, but no live adult fish suffering from the treatment were seen that day; no dead adults were seen on the water surface until November 9. The first large collection of dead fish was made on November 10, and fish continued to rise to the surface through November 21.

Maximum daily air temperatures at

Table 1.—Number of fish caught and number found alive in a single hoop net set in the old creek channel in Lake Glendale October 25–November 22, 1946, during latter part of the draining operation and period of rotenone treatment and recovery of fish killed. Draining of the lake, except for the part of the channel that was too low to drain, was completed on October 31. Rotenone was applied on the afternoons of November 6 and 8. The net was fished continuously but raised only on the dates shown.

Date	Largemouth Bass		Bluegills		Warmouths		Green Sunfish	
	Number in Net	Number Alive	Number in Net	Number Alive	Number in Net	Number Alive	Number in Net	Number Alive
Oct. 25	..	..	8	8	..	..	..	..
26	..	..	14	14	..	..	..	..
27	..	..	8	8	..	..	..	..
28	..	..	19	19	..	..	..	..
29	1	1	15	15	2	2	..	..
Nov. 1	21	21	355	355	17	17	1	1
4	11	11	144	144	63	63	2	2
7*	92	0	430	2	191	2	48	3
8	1	1	17	17	145	145	57	57
9	..	..	1	†	22	†	9	†
10‡	..	..	..	..	1	1	..	..
11	..	..	..	..	3	2	2	2
12	..	..	..	..	5	4	6	6
13	..	..	..	..	6	5	7	7
22	..	..	..	..	4**	3	10	10

* When the net was raised and reset without being emptied at 5 PM on November 6, practically all fish in the net were alive. This November 7 catch was observed at 10 AM; at 4 PM the net contained four bluegills, six warmouths, two green sunfish, and one black bullhead, all alive.

† Number alive not recorded. Probably some fish were dead as a result of the application of rotenone on November 8.

‡ On this and subsequent raises, the fish were counted but were left in the net.

** Two of the six warmouths left in the net on November 13 escaped or were eaten by turtles.

Harrisburg, about 25 miles north of Lake Glendale, during the 2 weeks of November 6-19, 1946, ranged from 53° to 69° F., while minimum temperatures ranged from 29° to 54° F. Maximum and minimum air temperatures on the dates of rotenone application were, respectively, 66° and 48° F. on November 6, and 58° and 46° F. on November 8 (U.S. Weather Bureau 1946:66).

Brown & Ball (1943:271-272) recorded an instance in which some of the fish killed with rotenone during a cold period in spring settled to the bottom and completely decomposed without coming to the surface.

The fact that most of the fish that came to the surface were coated with mud as much as one-eighth inch thick suggests that the weight of the mud prevented many fish from rising to the surface (or retarded the rise) even after bloating reached an advanced stage. Probably a large amount of silt which had been kept in suspension by the movements of the live fish settled over the dead fish after they had sunk to the bottom. The turbulence resulting from operating a small motorboat in the channel released some of the dead fish from the silt.

When it was found on November 21 that there were still dead fish on the bottom of the channel, a garden rake was used to release them from measured areas in order that they might be counted. In an area covering 960 square feet (24 × 40 feet) at the extreme downstream end of the channel, a thorough raking released 109 bluegills (primarily adult sizes), 19 largemouth bass (10 inches and smaller), and 7 adult warmouths. The rake was then dragged along the bottom of the channel from the stern of a rowboat for a distance of 900 feet; an area of 1,100 square feet was covered. In this second operation, 42 fish, mainly adult bluegills, were recovered. Obviously most of the dead fish on the bot-

tom were concentrated at the extreme downstream end of the channel.

On the basis of the above counts, the following estimates were made of the numbers of dead fish remaining on the bottom of the channel after the raking:

800 bluegills (165 pounds)

80 largemouth bass (22 pounds)

30 warmouths (5 pounds)

These estimates were added to the counts of the fish that were actually handled. No estimates were made of the number of live warmouths or of live green sunfish that survived poisoning.

All live fish of each species taken during the draining operation were sorted into readily recognized length groups; fish in these groups were counted and were weighed in lots of approximately 50 fish. The dead fish taken after the rotenone treatment were also sorted according to length; they were counted and were then weighed in groups, or group weights were approximated from the counts. All bass of exceptionally large sizes were measured; they were weighed individually or individual weights were approximated from a length-weight curve.

The census included fish of 2 inches or more in length. Some 2- to 3-inch fish may have escaped through the 1-inch-mesh screens before the hardware cloth was installed, but the number of these probably was not significant. Most of the fish less than 2 inches in length were bluegills that measured 0.75 inch to 1.5 inches, fish that probably were spawned 1 or 2 months before the draining operation. No estimate was made of the number of these small bluegills. Several thousand of them passed through the 1-inch-mesh screens before the 0.25-inch-mesh screens were put in place; thousands of others were stranded in the dense growth of water weeds during the initial 4-foot drop in water level. As shown by the following evidence, additional thousands of small bluegills must

have been eaten by adult bluegills, green sunfish, and bass during the late stages of draining, when the young fish were without any kind of weed protection. Eight of 20 large bluegills picked at random on October 26 from among the first lot of adult bluegills to leave the lake in the drain water contained small bluegills, most of them in fresh condition. Counts of these small bluegills found in the stomachs of the eight large bluegills were 2, 2, 3, 16, 18, 22, 24, and 28. A single green sunfish 5.5 inches long contained 13 small fish, all about 1 inch long, presumably bluegills. Two warmouths, one measuring 5 inches and the other 7 inches, had empty stomachs. A 19-inch largemouth bass had an empty stomach, but other bass were seen chasing small fish at the edge of the lake as the water level was falling. Bass predation on small bluegills occurred during the 1950 draining, and it can be assumed to have occurred also in 1946; on September 19-20, 1950, four bass of 8.7-9.8 inches caught on hooks in the creek channel within the lake basin contained 1, 2, 3, and 15 bluegills that were 0.75-1.25 inches long.

THE 1950 CENSUS OF THE BASS POPULATION.—The 1950 census of the population of largemouth bass was undertaken as a basis for an experimental reduction in the bass population. As in the 1946 census, the lake was lowered in the fall until the only water left was that remaining near the dam in a 1,300-foot stretch of the old stream channel and in isolated pools, which could not be drained (frontispiece). The bass collected at the screens below the drain outlet were counted. Some of the bass that failed to leave the lake during the draining were removed by hoop net and through electric shocking, and some were marked and returned to the water to be used to estimate the remaining population by the mark-and-recovery method. The actual numbers of bass removed by draining, shocking, and netting and the estimated numbers

Table 2.—Numbers and weights of largemouth bass in Lake Glendale at the time of the October, 1950, draining operation. Numbers and weights of fish removed in the operation were added to numbers and weights of those remaining (estimate made by mark-and-recovery method, Tables 3 and 4) to give the totals.

Census Group	Length Grouping, Inches							
	3-6.5 Inches		7-12.5 Inches		Over 12.5 Inches		All Sizes	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
Fish collected from drain water	343	10	1,034	373	7	13	1,384	396
Fish removed by other means	...	..	454*	169	..	..	454	169
Fish remaining (mark and recovery estimate)	...	..	2,415†	903	126‡	397	2,541	1,300
Total	343	10	3,903	1,445	133	410	4,379	1,865

* Of these fish, 439 were removed by shocking, 4 by angling, 11 by hoop net.

† From estimate shown in Table 3.

‡ From estimate shown in Table 4

that remained in the channel are shown in Table 2.

In the marking operation, 154 bass measuring 7 to 12.5 inches were marked by removal of the right pectoral fin. The area of skin from which a scale sample was removed served as a mark

for each of 79 bass longer than 12.5 inches.

The population estimates of bass of the two size categories shown in Tables 3 and 4 were obtained from the Schnabel formula cited by Ricker (1942:231) for estimating the size of a population

Table 3.—Estimates of number of 7–12.5-inch largemouth bass remaining in Lake Glendale after part of the population had been removed in the draining operation of October, 1950. The Schnabel method of computing populations from recovery of marked fish was used. The bass in only the first four samples were marked. Because of the length of time the marked fish had to mix with the unmarked fish, the last population estimate is assumed to be the most nearly accurate. This estimate (2,415 fish) is only slightly lower than the one obtained from sample 5 (before 439 bass in samples 5, 6, and 7 had been withdrawn) and was used in calculating the total population (Table 2).

Date	Sample	Number of Fish in Sample (A)	Number of Previously Marked Fish in Population at Time of Sampling (B)	Product (A B)	Sum of Products $\Sigma(A B)$	Number of Marked Fish in Sample (C)	Cumulative Sum of Marked Fish in Samples $\Sigma(C)$	Population Estimate $\Sigma(A B)$ $\Sigma(C)$
Oct. 11	1*	26	0	...	...	0	..	...
	2	27	26	702	702	1	1	702
	3	54	52	2,754	3,456	3	4	864
	4	52	103	5,356	8,812	1	5	1,762
	5	117*	154	18,018	26,830	6	11	2,439
	6	110*	148	16,280	43,110	6	17	2,536
	7	212*	142	30,104	73,214	11	28	2,615
Oct. 12	8	164	131	21,484	94,698	11	39	2,428
	9	70	131	9,170	103,868	4	43	2,415

* All fish in sample, including marked fish, were withdrawn from population after sample was examined for marks.

Table 4.—Estimates of number of largemouth bass measuring more than 12.5 inches remaining in Lake Glendale after part of the population had been removed in the draining operation of October, 1950. The Schnabel method of computing population from recovery of marked fish was used. The estimate made on October 12 (126 fish) is assumed to be the most nearly accurate and was used in calculating the total population (Table 2).

Date	Sample	Number of Fish in Sample (A)	Number of Previously Marked Fish in Population at Time of Sampling (B)	Product (A B)	Sum of Products $\Sigma(A B)$	Number of Marked Fish in Sample (C)	Cumulative Sum of Marked Fish in Samples $\Sigma(C)$	Population Estimate $\Sigma(A B)$ $\Sigma(C)$
Oct. 10	1	10	0	...	...	0	..	...
	2	12	10	120	120	0	..	...
	3	21	22	462	582	3	3	194
	4	13	40	520	1,102	5	8	138
	5	5	48	240	1,342	0	8	168
	6	16	53	848	2,190	6	14	156
Oct. 11	7	6	63	378	2,568	3	17	151
	8	9	66	594	3,162	6	23	137
	9	6	69	414	3,576	3	26	138
	10	8	72	576	4,152	5	31	134
Oct. 12	11	20	75	1,500	5,562	14	45	126

while marking is in progress. The population at any one sampling time is computed by the formula $\frac{\Sigma(AB)}{\Sigma(C)}$, in which A is the total number of fish in the sample, B is the number of marked fish in the entire population when the sample is taken, and C is the number of marked fish in the sample. The last in each series of population estimates (for example, the estimates based on Sample 9, Table 3, and Sample 11, Table 4) is assumed to be the most nearly accurate in the series.

The samples used in the mark-and-recovery estimate were obtained with an electric shocker carried in a boat (Fig. 5); the current was furnished by a 115-volt, 11-ampere generator. Samples were obtained in several runs, each covering about one-sixth to one-half of the 1,300-foot section of channel. All parts of this 1,300-foot section were covered in the course of the sampling. Because of the high turbidity of the water, only the fish that rose to the surface could be collected. Fish of each

of the two size categories shown in Tables 3 and 4 were not observed on all sampling trips with the shocker; hence the difference in number of samples shown in these tables.

In other tests of the accuracy of mark-and-recovery estimates of largemouth bass populations, a high degree of accuracy was reported in one pond (Carlander & Moorman 1956:663), moderate accuracy in three ponds, especially for bass more than 1 year old (Buck & Thoits 1965:606-607), and considerable inaccuracy in two ponds (Krumholz 1944:290; Hundley 1954:167). The degree of accuracy of the 1950 mark-and-recovery estimate of bass at Lake Glendale is perhaps fairly high due to the fact that the bass were concentrated in a small volume of water instead of being spread over the entire 82 acres. Because the bass were concentrated in a small space, there should have been the good mixing of marked and unmarked fish that is essential to obtaining close estimates of populations. A much larger percentage



Fig. 5.—Electrofishing for a mark-and-recovery estimate of the number of largemouth bass remaining in the stream channel after most of the water in Lake Glendale had been drained off in October, 1950.

of bass over 12.5 inches than below that length were marked, and the accuracy of the estimated population was therefore probably better for the larger bass than for the smaller ones.

STUDY PROCEDURES AT POUNDS LAKE

At the time Lake Glendale was stocked in April, 1940, the Natural History Survey also stocked Pounds Lake (Fig. 6), a 32-acre lake that had just been built on U.S. Forest Service land in Gallatin County, 40 miles northeast of Lake Glendale. A water sample from Pounds Lake, collected in May, 1963, had a total hardness of 26 ppm, which was similar to that of Lake Glendale and the ponds at Dixon Springs.

Pounds Lake was stocked at the rate of 1.7 adult bass and 3.6 adult bluegills per acre. The fish were of the same

sizes as those used in stocking Lake Glendale. (Lake Glendale was stocked at the rate of 0.9 adult bass and 2.6 adult bluegills per acre.) The Pounds Lake stock (55 largemouth bass and 120 bluegills), like the stock for Lake Glendale, came from Lake Chautauqua near Havana, Illinois. A rotenone treatment of the stream that feeds Pounds Lake, applied in 1939 before the water was impounded, failed to eliminate all of the green sunfish and yellow bullheads, *Ictalurus natalis* (Lesueur), in the stream. These species reproduced in the lake but were never very abundant. Five hundred mosquitofish, *Gambusia affinis* (Baird & Girard), were released in Pounds Lake by the local forest ranger in 1940.

The gizzard shad, *Dorosoma cepedianum* (Lesueur), a favorite forage fish of bass, was present in Pounds Lake in

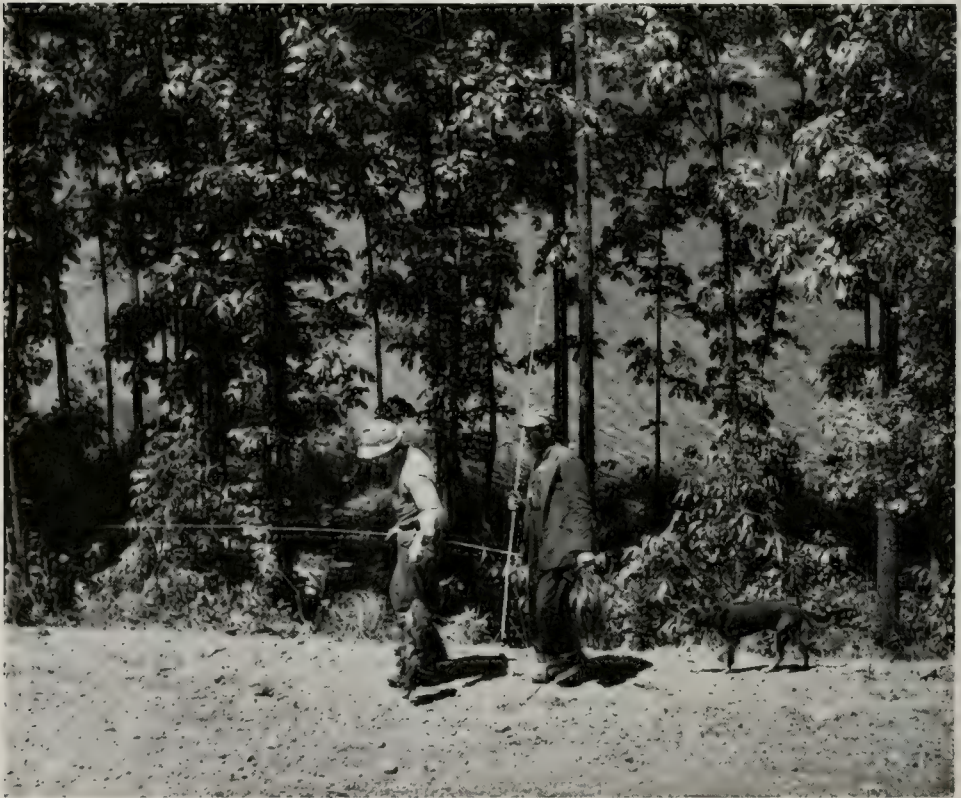


Fig. 6.—Fishermen with bluegills at Pounds Lake, May 16, 1942.

the fall of 1947 when the lake was drained, but scales examined from shad collected at that time suggest that this fish was introduced late in 1946 or early in 1947.

Pounds Lake, like Lake Glendale, was opened to fishing on May 15, 1942. Subsequently, except in 1943 and 1946 when the length of the fishing season at Lake Glendale was extended, the two lakes were opened to fishing each year on May 15 (the first day of the largemouth bass season in southern Illinois) and closed some time in September.

Through the cooperation of the Pounds Lake boat concessionaire, creel censuses were made for 6 weeks in 1943 and during most of the next three fishing seasons. The Pounds Lake record included numbers of fish kept by boat fishermen, but it did not include the weight of the fish kept or any data on baits. This record is assumed to have covered most of the fishing that was done during the periods shown in Table 8. The census covered neither private boats nor bank fishing, but Esden Jerrels, the concessionaire, pointed out that very few private boats were brought to the lake in the 1940's and that bank fishing at that time was very light.

In the years 1943-1945, a report was made out for each boat party, including the parties that returned without fish; it showed the number of fishermen in each boat and the number of each species of fish kept by the party. In the 1946 season, records were made for only those trips in which some member of the boat party kept one or more fish; therefore, the catch per trip for that season was not computed.

QUALITY OF FISHING FOLLOWING TWO PROGRAMS OF STOCKING

The success of a fish-stocking program may be measured by the quality of fishing as well as by fish-growth rates, size of standing crop of fish, and "balance" of species in the population.

The quality of fishing for bass and bluegills was markedly different in the two study periods at Lake Glendale. Bluegill fishing was decidedly better in the first period, after the lake had been stocked lightly in 1940 and kept closed to fishing for 2 years. Bass fishing was better in the second period, after the lake had been stocked more heavily in the fall of 1946 and opened to fishing the following spring.

The 2-year delay in opening the lake after the first stocking was necessitated by the small number of fish used in the stocking.

The first period, besides being the better of the two for bluegill fishermen, was also better for those fishermen who were not concerned about the kind of fish they caught; this period was the better in percentage of trips resulting in the capture of one or more fish (Table 5), in the total number and weight of fish harvested annually, and in the average number and weight of fish harvested per trip (Tables 6 and 7).

Striking differences between the two study periods were found in the ratios of total weight of bass to the total weight of bluegills harvested annually. Following the 1940 stocking, annual yields of bluegills (by weight) were 4 to 12 times as large as bass yields, while, for the first three seasons following the 1946 stocking, bluegill yields were smaller than bass yields (Table 7). But the catch of bluegills increased each year after 1947 until in 1950 the weight of bluegills finally exceeded that of bass. In three small unfertilized ponds at Dixon Springs (Hansen et al. 1960:365), the yields of bass were approximately the same as the yields of bluegills, whereas in three small fertilized ponds in the same study area the yields of bluegills were three times those of bass (each average based on three ponds fished for 5 years).

The 1940 introductions of fish at Pounds Lake and at Lake Glendale, with fewer than two adult bass and four adult bluegills per acre, was fol-

Table 5.—General information concerning sport fishing at Lake Glendale in the years following the 1940 stocking (first period) and after the 1946 stocking (second period). The data were derived from creel censuses.

Type of Information	First Period					Second Period			
	1942*	1943	1944	1945	1946	1947	1948	1949	1950
Number of trips†	2,754	1,308	859	973	1,517	407	1,110	1,032	1,544
Number of trips in which fish were kept	691	501	349	342	491	38	357	274	373
Percentage of trips in which fish were kept	25	38	41	35	32	9	32	27	24
Hours of fishing	..	7,174	3,951	4,421	7,380	1,425	4,329	4,748	6,888
Hours per trip	..	5.5	4.6	4.5	4.9	3.5	3.9	4.6	4.5
Hours per acre	..	87	48	54	90	17	52	58	84
Percentage of fishermen using the baits designated									
Plugs	..	18	17	25	22	31	42	34	27
Flies	..	12	19	14	15	9	16	16	13
Worms	..	51	36	47	55	33	17	21	37
Miscellaneous (including more than one bait)	..	19	28	14	8	26	25	29	22
Percentage of trips made by boat	..	80	79	79	69	69	89	88	87
Percentage of fishermen who were licensed (fishermen 18 years and older)	..	93	94	89	93	95	92	93	92

* Information on baits, hours of fishing, use of boats, and license status of fishermen was not collected in 1942.

† Trips were of various lengths. A trip, sometimes referred to as a man-day of fishing, represented the fishing done by one man on one day and could be from 6 AM to 9 PM, but was usually 2 to 8 hours.

lowed by similar fishing in the two lakes. Bluegill fishing (Table 8) was considered by many fishermen to be good at both lakes in the years 1943–1946. Bass fishing was considered poor at both lakes, except for the one good season at Pounds Lake in 1946.

The quality of fishing observed after three different stocking procedures tried in southern Illinois in the 1940's—stocking A used at Lake Glendale and at Pounds Lake in 1940, stocking B used at Lake Glendale in 1946, and stocking C used in three small unfertilized ponds at the Dixon Springs Agricultural Center in 1946—is shown in terms of the catch per hour in Table 9. Catch per hour (rather than catch per trip) was used for the reason that most of the trips to the small ponds were those of the test fishermen and lasted only 2 hours each instead of the 3.5 to 5.5 hours (yearly averages) recorded

at Lake Glendale. The best catch rates for bass and bluegills were observed in the ponds. Bass fishing during the best years at Lake Glendale was only about a third as good as bass fishing in the ponds. The ponds contained larger standing crops in pounds of fish per acre than did Lake Glendale (Table 28).

Analysis of Bass Fishing

That bass fishing at Lake Glendale was much better after the second stocking than after the first is shown in the number and weight of bass kept each year and bass kept per trip (Tables 6, 7, and 10). The total bass harvest in 1948, 637 fish weighing 591 pounds, greatly exceeded that of any other year. The best bass harvest in the period 1942–1946 came in the year the lake was opened to angling; throughout this period the catch rates were

Table 6.—Number of fish kept and number kept per trip at Lake Glendale in years following the 1940 stocking (first period) and the 1946 stocking (second period). The record is based on all fishing, sport fishing and test fishing combined, irrespective of baits used. The number in parentheses below each year indicates the total number of trips for that year.

Species	First Period					Second Period			
	1942 (2,754)	1943 (1,308)	1944 (859)	1945 (973)	1946 (1,517)	1947 (407)	1948 (1,110)	1949 (1,032)	1950 (1,544)
Largemouth bass									
Number kept	279	92	120	61	137	70	637	341	375
Number kept per trip	0.10	0.07	0.14	0.06	0.09	0.17	0.57	0.33	0.24
Bluegill									
Number kept	4,064	4,917	3,060	3,108	5,461	34	375	961	3,064
Number kept per trip	1.48	3.76	3.56	3.19	3.60	0.08	0.34	0.93	1.98
Green sunfish									
Number kept	1,712	432	457	196	150	1	58	64	95
Number kept per trip	0.62	0.33	0.53	0.20	0.10	..	0.05	0.06	0.06
Warmouth									
Number kept	..	1	65	96	273	..	14	53	97
Number kept per trip	..	..	0.08	0.10	0.18	..	0.01	0.05	0.06
Others*									
Number kept	20	30	140	18	6	..	4	..	14
Number kept per trip	..	0.02	0.16	0.02	..	..	..	..	0.01
All species									
Number kept	6,075	5,472	3,842	3,479	6,027	105	1,088	1,419	3,645
Number kept per trip	2.21	4.18	4.47	3.58	3.97	2.57	0.98	1.38	2.36

* Principally hybrid sunfish but a few bullheads.

Table 7.—Pounds of fish kept and pounds kept per trip at Lake Glendale in years following the 1940 stocking (first period) and the 1946 stocking (second period). The record is based on all fishing, sport and test fishing combined, irrespective of baits used. The number in parentheses below each year indicates the total number of trips in that year.

Species	First Period					Second Period				
	1942	1943	1944	1945	1946	1947	1948	1949	1950	
	(2,754)	(1,308)	(859)	(973)	(1,517)	(407)	(1,110)	(1,032)	(1,544)	
Largemouth bass										
Pounds kept	335	124	86	75	107	53	591	324	315	
Pounds kept per trip	0.12	0.09	0.10	0.08	0.07	0.13	0.53	0.31	0.20	
Bluegills										
Pounds kept	1,262	1,156	590	655	1,270	8	119	197	682	
Pounds kept per trip	0.46	0.88	0.69	0.67	0.84	0.02	0.11	0.19	0.44	
Green sunfish										
Pounds kept	324	68	66	36	26	..	12	14	20	
Pounds kept per trip	0.12	0.05	0.08	0.04	0.02	..	0.01	0.01	0.01	
Warmouth										
Pounds kept	..	..	10	21	67	..	4	15	31	
Pounds kept per trip	..	..	0.01	0.02	0.04	..	..	0.01	0.02	
Others										
Pounds kept	7	6	30	5	2	..	1	..	3	
Pounds kept per trip	..	..	0.03	..	..	..	..	..	..	
All species										
Pounds kept	1,928	1,354	782	791	1,472	61	727	550	1,051	
Pounds kept per trip	0.70	1.04	0.91	0.81	0.97	0.15	0.65	0.53	0.68	

Table 8.—Number of fish kept and number kept per trip by hook-and-line fishermen at Lake Glendale and Pounds Lake at corresponding times during the 1943–1946 fishing seasons. The fish caught at Pounds Lake were not weighed.

Year	Lake	Dates	Number of Trips	Largemouth Bass		Bluegill		Green Sunfish	
				Number Kept	Number Kept Per Trip	Number Kept	Number Kept Per Trip	Number Kept	Number Kept Per Trip
1943	Pounds Glendale	May 15–June 22 May 15–June 21	847 932	138 51	0.16 0.05	1,796 3,690	2.12 3.96	184 232	0.22 0.25
1944	Pounds Glendale	June 20–Sept. 3 June 22–Sept. 6	174* 342	45 66	0.26 0.19	1,082 1,147	6.22 3.35	98 231	0.56 0.68
1945	Pounds Glendale	May 15–Sept. 15 May 15–Sept. 13	1,212 958	66 61	0.05 0.06	3,453 3,034	2.85 3.17	153 196	0.13 0.20
1946	Pounds Glendale	May 1–Aug. 13 May 1–Aug. 13	† 1,099	432 82	.. 0.07	2,505 4,351	.. 3.96	375 68	.. 0.06

* The creel census did not begin at Pounds Lake in 1944 until the heavy fishing was over

† No records were made of trips at Pounds Lake in 1946 unless a fishing party returned with one or more fish. The catch of 432 largemouth, 2,505 bluegills, and 375 green sunfish in 1946 was the total catch of 173 fishing parties which included 359 fishermen. Probably at least a thousand trips were made in 1946.

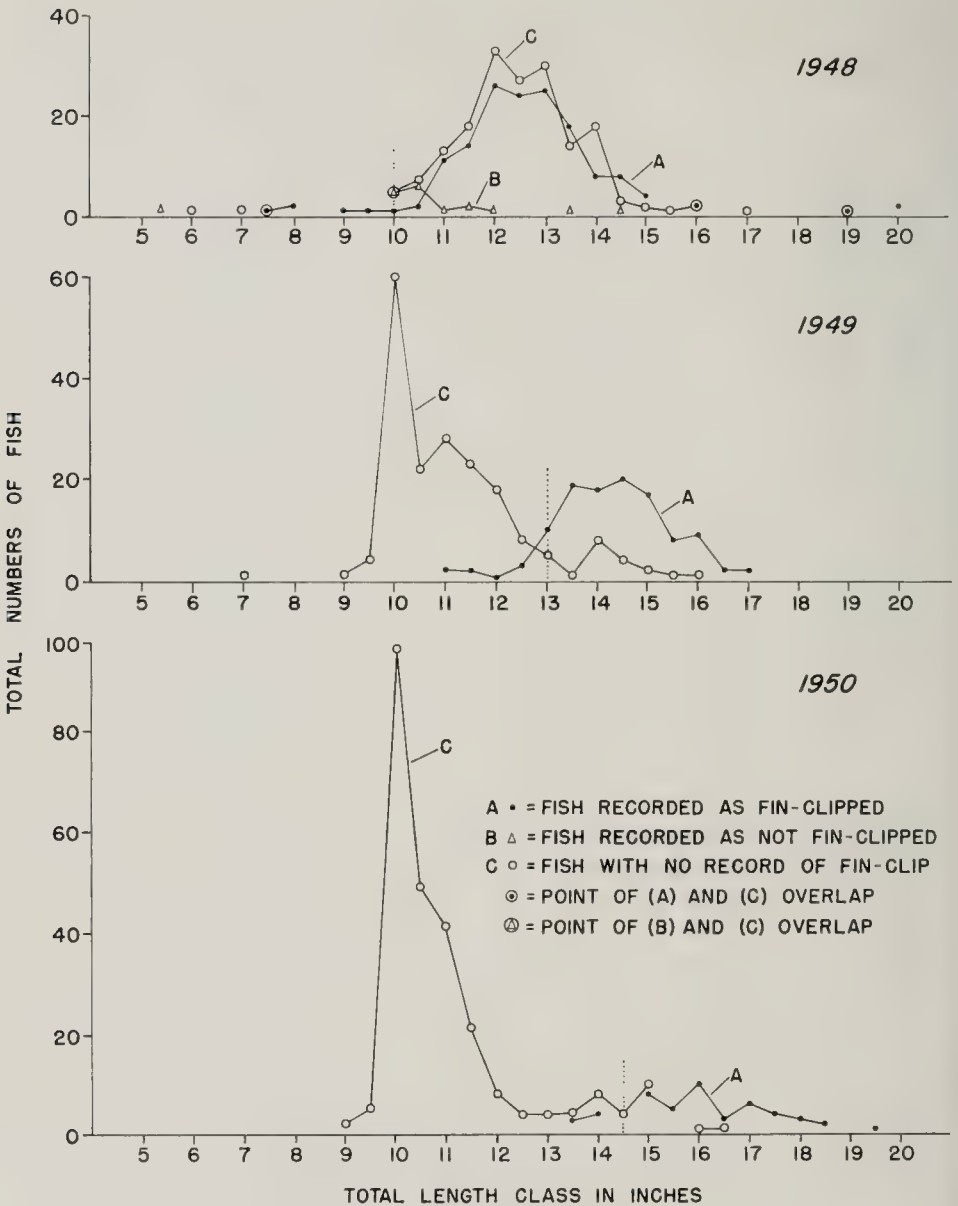


Fig. 7.—Length distributions of largemouth bass harvested by sport fishermen and measured by census clerks at Lake Glendale, 1948–1950. The occurrence of fin-clipped bass (the original stock) in the catch was recorded from time to time by census clerks—more consistently in 1949 and 1950 than in 1948. Fish recorded as fin-clipped are represented by curve A and those recorded as not fin-clipped (in 1948 only) by curve B. Fish for which no record was made of whether they were fin-clipped or not fin-clipped are represented in curve C. Some of the largest and smallest sizes of categories A, B, and C are shown as isolated points. Most of the fish of sizes indicated by the vertical dotted line and larger in each year are assumed to have been the original stock, although some of them were not reported as fin-clipped. Most of the fish of smaller sizes are assumed to have been members of new broods. The distributions of the fish measured indicate that bass of the original stock made up more than 90 per cent of the bass removed by sport fishermen in 1948, about half of those removed in 1949, and about a fifth of those removed in 1950.

Table 9.—Hook-and-line catch rates in southern Illinois waters in which different stocking procedures were used.*

Stocking Procedure, Lake, and Year of Stocking	Years Fished	Largemouth Bass		Bluegill	
		Number Per Hour	Pounds Per Hour	Number Per Hour	Pounds Per Hour
STOCKING A					
1-2 adult bass, 3-4 adult bluegills per acre					
Lake Glendale (1940)	1942-1946	0.02	0.02	0.64	0.14
Pounds Lake (1940)	1943-1945	0.03	†	0.76	†
STOCKING B					
27 fingerling and adult bass, 41 fingerling and adult bluegills per acre					
Lake Glendale (1946)	1947-1950	0.08	0.07	0.25	0.06
STOCKING C					
21-36 fingerling and adult bass, 310-412 fingerling bluegills per acre**					
Wells, Boaz, and Elam ponds (1946)	1947-1952‡	0.29	0.21	1.00	0.22

* Data for Lake Glendale and Pounds Lake derived as follows: Catch per trip (Tables 6, 7, and 8) divided by average lengths of trips shown in Table 5. Average lengths of trips at Lake Glendale in 1942 were arbitrarily set at 5 hours. Average lengths of trips at Pounds Lake were assumed to be the same as at Lake Glendale in 1943-1945. Data for Wells, Boaz, and Elam ponds are from Hansen et al. 1960:369.

† Fish caught at Pounds Lake were not weighed.

‡ Largemouth bass were caught each year, beginning in 1947, bluegills each year, beginning in 1948.

** The largemouth bass in this stocking were 6 to 10 inches long; the bluegills were about 1 inch long.

low. Annual harvests ranged from 0.7 to 3.4 bass per acre in the first period and from 0.9 to 7.8 per acre in the second period.

The bass with which Lake Glendale was stocked in 1946 figured prominently in the total bass harvest by sport fishermen in the first 3 years of the 1947-1950 period and contributed heavily to the harvest of the large bass caught throughout the period. The catch by the test fisherman (Table 13) indicates that all of the legal-size bass caught in 1947 were fish used in the 1946 stocking. The length-frequency curves in Fig. 7 suggest that more than 90 per cent of all bass harvested by fishermen in 1948, about half of those harvested in 1949, and about a fifth of those harvested in 1950 were fish used in the stocking. The curves in Fig. 7 also suggest that a great majority of the 10-, 11-, and 12-inch bass caught in 1949 and 1950 were offspring of the 1946 stock.

Catch rates for largemouth bass at Lake Glendale showed a peak in 1948, the second growing season after the 1946 stocking (Table 6). The catch rate for bass after the 1940 stocking was best in 1942; after 1942 catch rates were so low that the year-to-year differences could not be noticed by fishermen. At Pounds Lake the largest numbers of bass were taken in 1946, the seventh growing season (Table 8), but, as the record of the number of fishing trips in this season was incomplete, the catch rate was not calculated. The harvest at Pounds Lake was not observed in 1942, which, in terms of total bass harvest, was the best year in the first study period at Lake Glendale (Table 6). In each of the three unfertilized ponds at Dixon Springs (Hansen et al. 1960:384), a peak in bass catch rates occurred in the first growing season after stocking and one or two additional peaks occurred in the fourth, fifth, or sixth season.

Like the total bass harvest (Table 6), the harvest of bass with artificial baits was considerably better in 1947-1950 than in the earlier period (Table 10). In the fishing done with worms, the bass harvest showed some improvement in the second period, but not one that fishermen would have noticed.

In most years of each period, fly rod lures produced the best bass fishing in terms of number of fish harvested per trip, but casting rod lures produced the best bass fishing in terms of weight of fish harvested per trip (Table 10). The years 1947 and 1948 were the best in either period for catching bass on flies

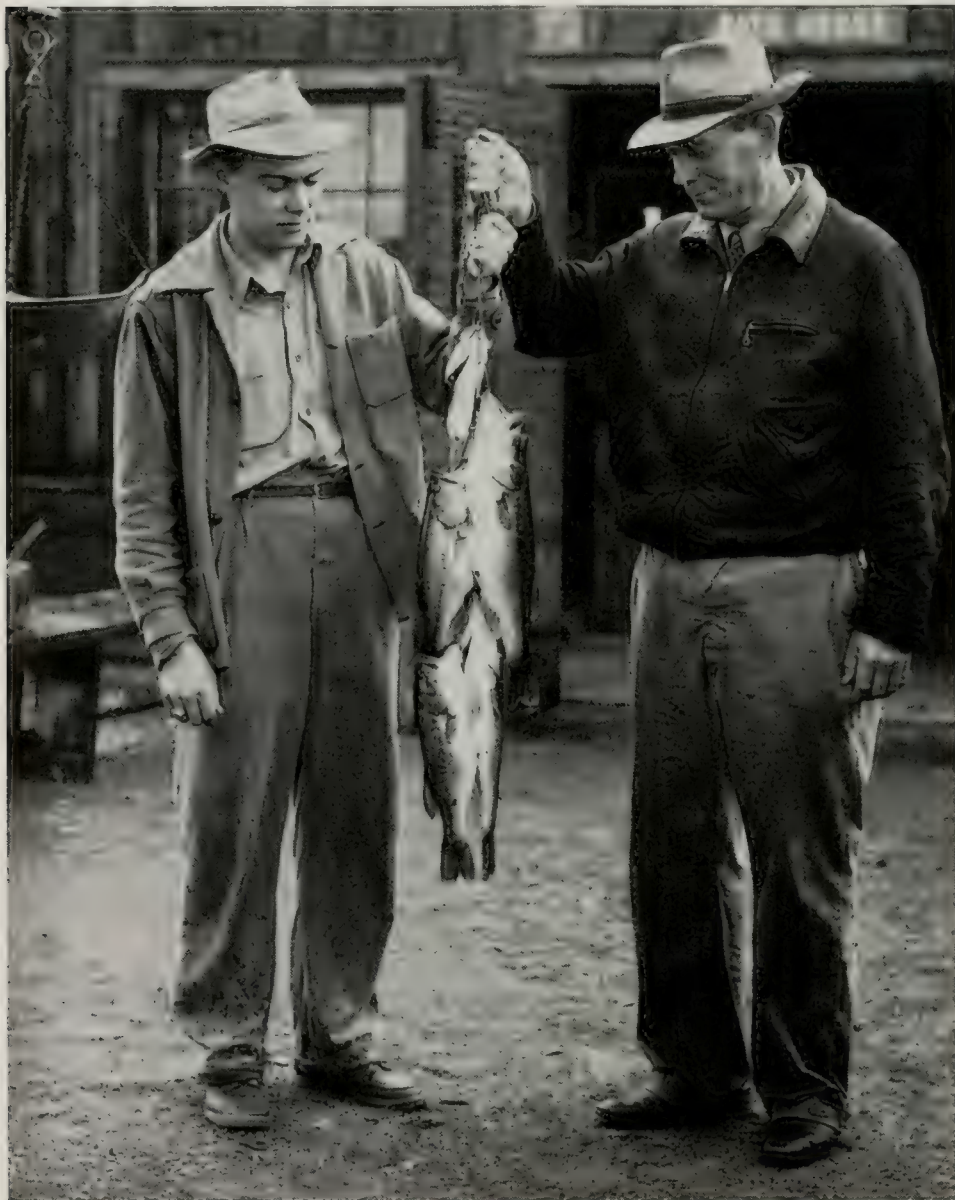


Fig. 8.—One fisherman's string of largemouth bass caught at Lake Glendale on the day the lake was first opened to fishing, May 15, 1942.

(number of bass per trip); 1948 was the best year for taking bass on plugs and worms. The lack of year-to-year consistency in the catch-rate figures for plugs and flies may have been due in part to sampling errors.

The superior bass fishing that took place on the first day of the 1942 season at Lake Glendale (Fig. 8) was followed by a sharp drop on the second day (Table 11). The cause of this drop was long a subject of discussion and argument among Glendale anglers. Forty per cent of the bass harvested in 1942 were caught on the first day of the season; 75 per cent were caught during the first 15 days of fishing. Most of the bass harvested the first day were

caught during the first 4 hours. The good fishing started at 6 AM and ended with the arrival of a cold front and a sharp drop in temperature at about 10 AM. The early season declines in other years, most noticeable in 1948 and 1949, were not as sharp as in 1942.

The phenomenon of a high rate of catch of bass at the beginning of a fishing season, followed by a rapid decline, has been reported at other lakes by Dill (1946:59-60), Bennett (1954: 256-261), and Bowers & Martin (1956: 8-9). Many of the fishermen at Lincoln Trail Lake, east-central Illinois, on the opening day of the 1958 fishing season reported that they caught the majority of their largemouth bass in the first 2

Table 10.—Catch of largemouth bass, and catch per trip, on various types of bait at Lake Glendale.* Fishing with spinning rods and spinning lures had not become popular at the time of this study.

	First Period				Second Period			
	1943	1944	1945	1946	1947	1948	1949	1950
Casting rod lures (plugs, etc.)								
Number of trips	231	143	247	334	128	463	350	424
Number of fish kept	47	25	19	20	29	354	148	154
Pounds kept	71.6	30.4	38.0	42.7	28.1	341.3	153.4	161.4
Number kept per trip	0.20	0.17	0.08	0.06	0.23	0.76	0.42	0.36
Pounds kept per trip	0.30	0.21	0.15	0.13	0.22	0.74	0.44	0.38
Fly rod lures (flies, poppers, etc.)								
Number of trips	162	162	138	222	38	173	169	201
Number of fish kept	12	54	16	35	27	125	80	92
Pounds kept	11.1	30.1	7.0	18.6	17.1	104.9	79.1	65.3
Number kept per trip	0.07	0.33	0.12	0.16	0.71	0.72	0.47	0.46
Pounds kept per trip	0.07	0.19	0.05	0.08	0.45	0.61	0.47	0.32
Worms†								
Number of trips	664	313	454	842	136	190	212	576
Number of fish kept	11	12	15	62	1	25	18	45
Pounds kept	13.5	5.2	14.5	33.8	0.5	23.5	13.5	32.6
Number kept per trip	0.02	0.04	0.03	0.07	0.01	0.13	0.08	0.08
Pounds kept per trip	0.02	0.02	0.03	0.04	...	0.12	0.06	0.06
Miscellaneous baits								
Number of trips	251	241	134	119	105	284	301	343
Number of fish kept	22	29	11	20	13	133	95	84
Pounds kept	27.5	20.4	15.5	11.7	7.6	121.2	77.9	55.9
Number kept per trip	0.09	0.12	0.08	0.17	0.12	0.47	0.32	0.24
Pounds kept per trip	0.11	0.08	0.12	0.10	0.07	0.73	0.26	0.16

* Trips represented under casting rod lures, fly rod lures, and worms are those in which the named bait types were the only ones used. Less frequently used baits, such as crayfish and cockroaches, and combinations of baits, such as plugs and worms, on the same trip, are lumped under miscellaneous baits. The total harvest of largemouth bass (all baits) is given in Table 6. The kinds of baits used were not recorded in 1942.

† Includes garden worms, nightcrawlers, manure worms (commercial red wigglers), and certain insect larvae, such as catalpa worms.

Table 11.—Harvest of largemouth bass at Lake Glendale during first 15 days of the 1942 season. The lake was closed to fishing on Monday of each week.

Date	Number of Trips*	Number of Bass Kept
May 15	151	112
16	130	25
17	331	18
18 (lake closed)	..	..
19	55	13
20	27	1
21	40	5
22	36	10
23	53	2
24	188	3
25 (lake closed)	..	..
26	17	4
27	32	3
28	50	5
29	20	2
30	105	7
31	99	3

* Number of trips is the same as number of fishermen visiting the lake or man-days of fishing, irrespective of baits used, and covers all fishermen whether they were fishing especially for bass or not. There were no trips by test fishermen in 1942.

hours of fishing (Lopinot 1958:5). Eschmeyer (1942:101) reported that during the 1940 season at Norris Reservoir, Tennessee, 71 per cent of the fish harvested (many of them largemouth bass) were caught in June, the first month of fishing.

Dill (1946:60) thought that the presence of relatively large numbers of "bass fishermen" during the first few days of a new season was an important factor in the large early-season bass harvest. Bennett (1954:260) suggested that either the more aggressive bass were caught easily during the first few hours of fishing or that under heavy fishing at the start of the season the bass that escaped early capture might become wary of boats and fishermen's baits. Eschmeyer (1942:101) and Byrd (1959:230) believed that the early-season drop in catch (observed in fishes of various kinds) might have resulted primarily from a reduction in the pop-

Table 12.—Average weights (pounds) of the largemouth bass caught and kept by Lake Glendale anglers using different types of bait.*

	First Period					Second Period			
	1942†	1943	1944	1945	1946	1947	1948	1949	1950
Casting rod lures (plugs, etc.)									
Number of bass	...	47	25	19	20	29	354	148	154
Pounds of bass	...	72	30	38	43	28	341	153	161
Average weight	...	1.53	1.20	2.00	2.15	0.97	0.96	1.03	1.05
Fly rod lures (flies, poppers, etc.)									
Number of bass	...	12	54	16	35	27	125	80	92
Pounds of bass	...	11.1	30.1	7.0	18.6	17.1	104.9	79.1	65.3
Average weight	...	0.93	0.56	0.44	0.53	0.63	0.84	0.99	0.71
Worms‡									
Number of bass	...	11	12	15	62	1	25	18	45
Pounds of bass	...	13.5	5.2	14.5	33.8	0.5	23.5	13.5	32.6
Average weight	...	1.23	0.43	0.97	0.55	0.50	0.94	0.75	0.72
All baits‡									
Number of bass	279	92	120	61	137	70	637	341	375
Pounds of bass	335	124	86	75	107	53	591	324	315
Average weight	1.20	1.35	0.72	1.23	0.78	0.76	0.93	0.95	0.84

* Trips represented under casting rod lures, fly rod lures, and worms are those in which the named bait types were the only ones used. Less frequently used baits, such as crayfish and cockroaches, and combinations of baits, such as plugs and worms, on the same trip, are lumped under miscellaneous baits. The total harvest of largemouth bass (all baits) is given in Table 6.

† No record of baits was kept in 1942.

‡ Includes garden worms, nightcrawlers, manure worms (commercial red wigglers), and certain insect larvae, such as catalpa worms.

ulation of fish of harvestable sizes. Eschmeyer (1942:110) estimated that the harvest of game fish at Norris Reservoir in June, 1940, was about 14 per cent of the population of legal-size game fish at the beginning of the fishing season and that the harvest for the entire fishing season (June–November) was only about 20 per cent of this population. Bennett (1954:259–260) found at Ridge Lake that the best bass fishing

in each of four seasons occurred on the morning of the opening day and dropped off sharply after only a small proportion of the bass population had been caught.

The real reason for the drop in bass fishing success in the course of the opening day of fishing at Lake Glendale remains unknown. Several factors may have been involved. A substantial number of the least wary bass, the most

Table 13.—Size distribution of largemouth bass caught at Lake Glendale by Natural History Survey test fishermen, 1944–1950. Most of the fishing was done with fly rods and small popper flies. An asterisk (*) following a number indicates recorded fin-clipped bass of the 1946 stocking, except as noted for 1948. The legal length of bass at the time of this study was 10 inches. The 10-inch class (below broken line in table) includes fish measuring 9.8–10.2 inches.

Length Class, Inches	First Period			Second Period			
	1944	1945	1946	1947	1948†	1949	1950
4.0				1			
4.5	3			..	1	1	
5.0	1	1		..	..	1	1
5.5	6	1	2	1	1	2	1
6.0	2	3	7	..	3	3	2
6.5	19	6	10	..	1	1	6
7.0	8	8	7	..	4	7	2
7.5	13	8	5	..	15	17	6
8.0	29	21	25	4*	6	30	24
8.5	92	24	30	4*	6	24	21
9.0	100	20	35	7*	3	28	27
9.5	47	10	31	6*	5	19	35
10.0	54	5	24	9*	..	13	34
10.5	12	4	10	12*	2‡	7	10
11.0	2	..	3	11*	2*	1	2
11.5	1	3	2	7*	7*	4	6
12.0	1	..		4*	6*	3	..
12.5	1	1		1*	4*	1	..
13.0	1	..		..	2*	..	..
13.5	..	1		..	4*	1*	..
14.0	..			..	1*	..	1
14.5	..			..	1*	2*	1
15.0	..			..		1*	
15.5	..			..		1*	
16.0	..			..			
16.5	1			..			
17.0	..			..			
17.5	..			..			
18.0	1			..			
18.5	1			1*			
Total	395	116	191	68	74	167	179

* Recorded fin-clipped bass of the 1946 stocking.

† In 1948, the number of fin-clipped bass of the 1946 stocking was based partly on size of fish. It was assumed that, because of their size, all of the fish of 11 inches and longer were of the 1946 stock (*) even though not all of these fish were recorded as fin-clipped. In the various length classes, the numbers of fish actually recorded as fin-clipped were as follows: 10.5-inch length class—1 fish; 11—0; 11.5—5; 12—3; 12.5—3; 13—0; 13.5—1; 14—1; 14.5—1.

‡ One of these two fish was recorded as fin-clipped; the other was recorded as not fin-clipped.

Table 14.—Size distribution of largemouth bass caught at Lake Glendale by sport fishermen under the permit system, as indicated by a sampling of the bass caught. Measurements in 1942 and 1944 were made by Natural History Survey biologists, those in 1947–1950 by creel-census clerks. The size distributions of bass caught by test fishermen are shown in Table 13 and the total bass harvest in Table 6.

Length Class, Inches	First Period		Second Period			
	1942*	1944†	1947	1948	1949	1950
10.0	4	30	1	11	60	97
10.5	2	11	3	15	26	49
11.0	7	5	13	25	29	43
11.5	1	3	5	34	25	21
12.0	8	..	..	60	19	8
12.5	3	1	3	51	11	4
13.0	2	1	..	55	15	4
13.5	5	1	..	33	20	7
14.0	7	..	1	26	26	12
14.5	3	..	..	12	24	4
15.0	9	..	..	6	19	18
15.5	3	1	..	1	9	5
16.0	..	..	..	4	10	11
16.5	..	..	1	..	2	4
17.0	..	3	..	1	2	6
17.5	..	1	..	..	..	4
18.0	..	1	1	..	..	3
18.5	4	..	1	..	..	2
19.0	4	..	..	2	..	..
19.5	..	..	..	..	..	1
20.0	..	..	..	2	..	..
Total	62	58	29	338	297	303

* The fish included in this column represented 22 per cent of the bass harvested by anglers in 1942. They were taken early in the fishing season, most of them on opening day, May 15.

† Lengths observed by a Natural History Survey biologist stationed at the creel-census station on Sundays during June, July, and August.

willing biters, or the most aggressive individuals may have been removed from the lake during the first few hours. Other possibilities are that the appearance of boats, baits, and fishermen frightened many bass to offshore waters, where boat traffic and fishing were comparatively light, while the bass that remained within range of fishermen quickly acquired wariness. Possibly the 112 bass harvested during the first day represented a fairly large proportion of the total population of large bass, although the number of large bass in the lake on opening day is not known.

It should be kept in mind that the initial good fishing at Lake Glendale in 1942 was followed by a drop and not by a complete collapse in fishing success. Undoubtedly, during the fishing season, some recruitment of bass into

the catchable population occurred as a result of growth of individuals. Possibly many bass did not develop strong fears of boats and baits, and some bass that developed such fears may have overcome them in the course of the season. One of several bass placed in Phelps Pond near Lake Glendale in 1946 and later marked by removal of scales at each capture, was caught by the test fisherman three times in 1947 between June 20 and July 16. The fish was 9 inches long at its last capture. The bass in this pond were growing slowly, and frequent biting may have resulted from extreme hunger.

While the number of bass harvested at Lake Glendale was greater in the second study period than in the first (Table 6), the average weight of all bass harvested was greater in the first period (Table 12). However, the aver-

age weight of the bass taken on flies was greater in the second period (Table 12). In 1948, the average weight of the bass taken on plugs was about the same as that of the bass taken on flies or worms. In most other years the bass caught on plugs averaged about a quarter pound to more than a pound heavier than those caught on flies or worms.

Although the difference between periods in average weights of bass harvested was small (Table 12), there were important differences between

One reason the test fishermen caught very few large bass may have been that they fished almost exclusively with small flies and poppers. Also, the test fishermen started fishing 2 to 4 weeks later in the season than other fishermen, which in the opinion of some fishermen in southern Illinois reduced their chances of catching large bass.

According to reports made by sport fishermen to the census clerks, more small bass were caught and thrown back in the lake in 1942–1946 than in

Table 15.—Number of largemouth bass kept and number thrown back by fishermen at Lake Glendale.

	First Period					Second Period			
	1942	1943	1944	1945	1946	1947	1948	1949	1950
Number of bass kept	279	92	120	61	137	70	637	341	375
Number of bass thrown back*	9,369	3,397	2,659	1,280	1,908	140	1,453	1,477	1,613
Total number of bass caught	9,648	3,489	2,779	1,341	2,045	210	2,090	1,818	1,988
Number of trips	2,754	1,308	859	973	1,517	407	1,110	1,032	1,544
Number of bass thrown back per trip	3.40	2.60	3.09	1.31	1.26	0.34	1.31	1.43	1.04
Number of bass thrown back: number kept	34	37	22	21	14	2	2	4	4
Per cent of catch thrown back	97	97	96	95	93	67	70	81	81

* Based mainly on estimates by fishermen; 1944–1950 includes bass under 10 inches caught by test fishermen.

periods in the length distribution of the legal-size bass caught (Tables 13 and 14). In 1944–1946, most of these bass were either just over the legal size, that is, 10–11 inches, or were fairly large, 17 inches or larger. A similar distribution of sizes was found in the 1946 population census (Table 22). The bass caught in 1948–1950 included not only individuals of these sizes, but also large numbers of bass of intermediate sizes, those measuring 12–16 inches.

Hoop nets gave an erratic picture of size distribution of bass in Lake Glendale, but they seemed to show that 12–16-inch bass were more abundant in 1942, 1943, and 1944 than in 1945 and 1946 (Table 21).

1947–1950 (Table 15). Even in years of the best bass fishing, the number of bass thrown back exceeded the number kept. The sizes of bass under 10 inches in length caught by the test fishermen (Table 13) are assumed to have been approximately the sizes of bass that were caught and returned to the water by the sport fishermen.

Analysis of Bluegill Fishing

In terms of year-to-year harvest and harvest per trip, bluegill fishing at Lake Glendale (Fig. 9), in contrast to bass fishing, was much better in 1943–1946 than in 1947–1950 (Tables 6, 7, and 16). A number of experienced fishermen claimed that Glendale in the years 1943–1946 was one of the best bluegill

lakes in southern Illinois. The bluegill harvest per trip at Lake Glendale in this period was about the same as at Pounds Lake, although the best single year was observed at Pounds (Table 8).

Bluegill fishing at Lake Glendale in 1943-1946 (the 4 best years) was not

as good as bluegill fishing in three unfertilized ponds near Dixon Springs (Hansen et al. 1960:368-369), but it was better than that recorded in 1961 at two other southern Illinois lakes, namely, Murphysboro (160 acres) and Horseshoe (2,400 acres) (Lopinot 1962: 20-21). The catch rates reported for



Fig. 9.—Bluegills caught at Lake Glendale on opening day, May 15, 1942.

bluegills taken on flies were better at Lake Glendale in 1943–1946 (Table 16) than at Lake Murphysboro in 1955 (Lewis et al. 1957:35). The catch rates reported for bluegills taken on cockroaches at Crab Orchard Lake (61 hours of fishing) were considerably better than the catch rates for bluegills taken on flies, worms, or miscellaneous baits at Lake Glendale in any year

(Table 16). The stocking rates used at Murphysboro, Crab Orchard, and Horseshoe lakes are not known. The three lakes contained a greater variety of fish species than Lake Glendale.

Average weights of bluegills kept by Lake Glendale fishermen were similar in the two periods (Table 17). Only in 1942 and 1948 did the bluegills average more than 0.25 pound each. The

Table 16.—Catch of bluegills and catch per trip on various types of bait at Lake Glendale.*

	First Period				Second Period			
	1943	1944	1945	1946	1947	1948	1949	1950
Casting rod lures (plugs etc.)								
Number of trips	231	143	247	334	128	463	350	424
Number of fish kept	15	33	84	58	..	16	25	101
Pounds kept	2.8	7.7	17.0	18.9	..	5.2	5.4	20.3
Number kept per trip	0.06	0.23	0.34	0.17	0.00	0.03	0.07	0.24
Pounds kept per trip	0.01	0.05	0.07	0.06	0.00	0.01	0.02	0.05
Fly rod lures (flies, poppers, etc.)								
Number of trips	162	162	138	222	38	173	169	201
Number of fish kept	494	394	476	469	1	31	183	141
Pounds kept	101.9	63.4	96.8	100.8	0.3	9.1	35.8	26.9
Number kept per trip	3.05	2.43	3.45	2.11	0.03	0.18	1.08	0.70
Pounds kept per trip	0.63	0.39	0.70	0.45	0.01	0.05	0.21	0.13
Worms†								
Number of trips	664	313	454	842	136	190	212	576
Number of fish kept	3,678	1,977	2,280	4,551	7	128	427	1,946
Pounds kept	885.6	388.4	486.8	1,061.4	1.6	40.5	86.6	455.6
Number kept per trip	5.54	6.32	5.02	5.40	0.05	0.67	2.01	3.38
Pounds kept per trip	1.33	1.24	1.07	1.26	0.01	0.21	0.41	0.79
Miscellaneous baits								
Number of trips	251	241	134	119	105	284	301	343
Number of fish kept	1,224	701	268	383	26	200	326	876
Pounds kept	267.2	131.0	54.8	89.2	6.0	63.9	69.6	178.9
Number kept per trip	4.89	2.91	2.00	3.22	0.25	0.70	1.08	2.55
Pounds kept per trip	1.06	0.54	0.41	0.75	0.06	0.23	0.23	0.52

* Trips represented under casting rod lures, fly rod lures, and worms are those in which the named bait types were the only ones used. Less frequently used baits, such as crayfish and cockroaches, and combinations of baits, such as plugs and worms, on the same trip, are lumped under miscellaneous baits. The total harvest of bluegills (all baits) is given in Table 6.

† Includes garden worms, nightcrawlers, manure worms (commercial red wigglers), and certain insect larvae, such as catalpa worms.

Table 17.—Average weights (pounds) of bluegills caught and kept by anglers at Lake Glendale.

	First Period					Second Period			
	1942	1943	1944	1945	1946	1947	1948	1949	1950
Number of bluegills	4,064	4,917	3,060	3,108	5,461	34	375	961	3,034
Weight of bluegills	1,262	1,156	590	655	1,270	8	119	197	682
Average weight	0.31	0.24	0.19	0.21	0.23	0.24	0.32	0.20	0.22

length distributions of bluegills caught by test fishermen is shown in Table 18. (No record was made of lengths of bluegills caught by other fishermen.) The length distribution of bluegills captured in hoop nets during the early spring, 1941-1950, is shown in Table 24.

All of the bluegills harvested by sportsmen in 1947 were fish used in the 1946 stocking, and the largest bluegills harvested in 1948 and 1949 were from the 1946 stock (Table 18). In contrast,

most of the large bluegills caught by sportsmen in 1942 and 1943 were fish belonging to the first brood produced in the lake (in 1940). However, the largest bluegills caught in these years—some measuring up to 10 inches—were from the original stock (215 bluegills).

In each year after the light (1940) stocking, the number of bluegills kept exceeded the number thrown back in the lake (Table 19). Not until the fourth year after the heavier (1946)

Table 18.—Size distributions of bluegills caught at Lake Glendale by Natural History Survey test fishermen, 1944-1950. An asterisk (*) following a number indicates recorded fin-clipped bluegills of the 1946 stocking. Most fish were caught with fly rod and small popper flies.

Length Class, Inches	First Period			Second Period			
	1944	1945	1946	1947	1948	1949	1950
3.0	1						
3.5	1					2	
4.0	8	1			2	1	
4.5	5		1		1	5	3
5.0	11	2	1	1*	4	17	6
5.5	51	17	3	1*	4	22	21
6.0	69	69	32	1*	5	21	16
6.5	135	81	68	3*		10	18
7.0	86	181	111	12*	2*	1	18
7.5	11	32	38	5*	3*	2*	
8.0	4	1	4		3*	5*	
8.5					1*	1*	
9.0		1					
Total	382	385	258	23	25	87	82

* Fin-clipped bluegills of the 1946 stocking.

Table 19.—Number of bluegills kept and number thrown back by fishermen at Lake Glendale.

	First Period					Second Period			
	1942	1943	1944	1945	1946	1947	1948	1949	1950
Number of bluegills kept	4,064	4,917	3,060	3,108	5,461	34	375	961	3,064
Number of bluegills thrown back*	3,492	3,412	2,216	1,168	1,934	35	657	1,262	2,479
Total number of bluegills caught	7,556	8,329	5,276	4,276	7,395	69	1,032	2,223	5,543
Number of trips	2,754	1,308	859	973	1,517	407	1,110	1,032	1,544
Number of bluegills thrown back per trip	1.27	2.61	2.60	1.22	1.27	0.09	0.59	1.22	1.61
Number of bluegills thrown back: number kept	0.9	0.7	0.7	0.4	0.4	1.0	1.8	1.3	0.8
Percentage of catch thrown back	46	41	42	27	26	51	64	57	45

* Based mainly on estimates by fishermen; 1944-1950 includes bluegills under 6 inches caught by test fishermen.

stocking did the number kept exceed the number thrown back. In each year, the percentage of the catch thrown back was lower for bluegills than for bass (Tables 15 and 19).

Bluegill catch rates at Lake Glendale reached a plateau in the fourth growing season (1943) after the 1940 stocking (Table 6). The catch rates showed steady improvement through the fourth growing season (1950) after the 1946 stocking. As late as 1950, however, the quality of bluegill fishing during the second period was not up to that observed in the better years of the first period. At Pounds Lake, bluegill catch rates rose to a peak in the fifth growing season (1944) after the 1940 stocking (Table 8). In the three unfertilized ponds near Dixon Springs (Hansen et al. 1960:384), there was a tendency toward a gradual improvement in bluegill catch rates, with peak rates coming in the fifth or sixth growing season after the stocking.

Annual harvest rates of bluegills, in number per trip at Lake Glendale, were one and a half to five times as good with worms as with flies (Table 16). Unexpectedly large numbers of bluegills were caught by sport fishermen and test anglers while plug fishing for bass. For example, in 1950, 101 bluegills were caught on plugs in 424 trips and 141 on flies in 201 trips (Table 16).

Fishing for Warmouths and Green Sunfish

Since the numbers of warmouths and green sunfish introduced into Lake Glendale are unknown, and the numbers that survived after the 1946 census are also unknown, a comparison of quality of fishing for the years 1942–1946 and 1947–1950 would have little meaning in this evaluation of stocking rates. The numbers of warmouths caught increased from year to year in 1943–1946 and again in 1948–1950, but the species did not become important during either period (Table 6).

The numbers of green sunfish harvested by fishermen declined in the period 1942–1946 from an initial high in 1942 but increased in the later period (Table 6). More green sunfish of harvestable sizes were reported in the 1946 creel (Table 6) than were found in the population census at the end of the fishing season (Table 27). At no time was fishing as productive for warmouths or green sunfish as for bluegills (Tables 6 and 7). In 1942, the weight of the green sunfish harvest was nearly equal to the weight of the harvest of largemouth bass (Table 7). It would appear from the number of harvestable fish in the population at the time of the census in 1946 (Table 27) and the number harvested by fishermen in that year that green sunfish were more vulnerable to capture than any of the other species at Lake Glendale; the green sunfish were followed in order of vulnerability by the largemouth bass, bluegill, and warmouth. Larimore (1957:70) found that in one Illinois pond largemouth bass of the original stock were more susceptible to capture than warmouths of the original stock.

Lake Glendale warmouths showed a preference for live baits. In 1946, 842 fishermen using worms caught 205 warmouths, while 222 fishermen using artificial flies caught only 8 warmouths (not shown in tables). Larimore (1957:69) stated that the warmouth in most of its range is taken more commonly on natural baits than on artificial baits.

The green sunfish at Lake Glendale apparently showed a preference for artificial flies. In 1943, the first year in which bait records were kept at Lake Glendale, 162 fly fishermen caught 159 green sunfish, whereas 664 worm fishermen caught 227. However, most of the fly fishing was done along the margin of the lake, a region preferred by green sunfish, whereas a considerable part of the worm fishing was done offshore in water deeper than that usually frequented by green sunfish.

EFFORTS TO IMPROVE FISHING

Following the light stocking at Lake Glendale in 1940 and before any thought had been given to a new stocking (as finally carried out in the fall of 1946), a number of experimental attempts were made to improve fishing in the lake. None of these attempts was effective. For example, in early September, 1944, when the lake level stood 19 inches below full stage, the level was dropped 40 inches more. This drop resulted in a 22 per cent reduction in the lake area, from a normal area of 82 acres to 64 acres. This is not as much of a reduction as is recommended for a successful drawdown (Bennett 1962:160). The lake level remained low through the fall months, rising only 6 inches during a period of 12 weeks, September 8 through November 30; the lake refilled during the winter. It had been speculated that removal of the water from the fringe of cattails surrounding the lake would expose young bluegills to predation by bass and increase the growth rates of the bluegills (through reduced competition for food). However, the young bluegills received protection from underwater plants, particularly chara, as the water dropped below the level of the cattails. Little change could be seen in sizes of bluegills caught after this slight reduction in water level. Bluegills larger than 6 inches caught by test fishermen (Table 18) averaged 6.6 inches in the summer of 1944 before the drawdown, 6.75 inches in 1945, 6.8 inches in 1946 (these averages not shown in table). Furthermore, bluegill catch rates changed only slightly in the 2 years after the reduction (Tables 6, 7, and 16). The reduction in water level was not followed by changes in catch rates of bass or in sizes of bass caught (Tables 6, 7, 10, and 13).

Several changes were made in Lake Glendale fishing regulations in the hope that bass harvests might be improved. The restriction against use of live minnows was dropped for the 1943 season;

there was little indication that minnows were more effective than other bass baits. In 14 trips in which minnows were the only bait used, fishermen caught only 2 bass of legal size. In 231 trips in which plugs were used in 1943, fishermen caught and kept 47 bass (Table 10). In another management attempt in 1943, the fall fishing season was extended to include the 12 Sundays in the period September 12 through November 28. During this special season of Sunday fishing, 32 fishermen using plugs harvested 12 bass weighing a total of 8 pounds. During the regular season, May 15 through September 11, 199 fishermen using plugs harvested 35 bass weighing a total of 63 pounds. The number of bass caught per trip was therefore much better during the special season than during the regular season, while weight per trip was slightly better during the regular season. During a special open season early in the spring of 1946, when fishing was allowed on the five Sundays preceding the regular May 15 opening, 155 fishermen using plugs harvested 14 bass having a total weight of 27 pounds. During the regular 1946 season, May 15 through September 22, 179 fishermen using plugs harvested 6 bass weighing 15 pounds.

GROWTH OF FISHES

Because good sport fishing depends on the availability of desirable sizes of fish, the growth in both the original stock and the new broods was studied at Lake Glendale. Year-to-year growth was studied from changes in length-frequency distributions and, to a limited extent, from examinations of scale samples. The scale samples used in making age determinations were collected either before or near the end of the growing season; thus, most of the uncertainties in fish ages caused by variations in time of annulus formation were avoided.

In the first study period, when few largemouth bass were harvested (Table

14), most of the bass in the 12-15.5-inch range were "cannibals"—exceptionally fast-growing individuals that derive their name from the supposition (at least correct for hatchery-reared bass) that they feed principally on their slower-growing brood mates. At the start of fishing in the second study period, the bass harvest was made up principally of fast-growing fish of the 1946 stock; toward the end of the period, they were made up principally of noncannibal members of broods spawned in the lake. Cannibals probably made a less significant contribution to the harvest during the second study period than during the first.

In the years of fair to good bluegill fishing during the first period, and in the one year of fair bluegill fishing in the second period (1950), the bluegill harvests were made up largely of fish from broods produced in the lake after the stockings. In 1947 and 1948, the poor bluegill harvests were made up principally of fish of the 1946 stocking.

Growth of Original Bass

The largemouth bass with which Lake Glendale was stocked in April, 1940, grew rapidly. Those from which scales were obtained were found to have grown much more rapidly than is usual for bass in older populations. Bass of 10-14 inches (the sizes of the bass used in stocking Lake Glendale in 1940) ordinarily increase their weights at the rate of a quarter pound to a half pound a year. Six bass of the 1940 stock caught in hoop nets in March, 1943, had put on weight at the rate of 1 to 2 pounds per year. At that time, they ranged from 18.4 to 21 inches in length and from 3.7 to 6.4 pounds in weight. One of the 1940 original bass taken in the 1946 population census weighed 8 pounds, 9 ounces, and measured 23.4 inches. This is the largest bass that has been recorded from Lake Glendale.

The bass with which the lake was stocked in 1946 grew less rapidly than

those of the 1940 stocking but more rapidly than bass in most old populations. Shifts in the modes of the length-frequency distributions for bass caught

Table 20.—Numbers of marked (fin-clipped) largemouth bass of three length categories used in stocking Lake Glendale in the fall of 1946, and size distributions of part of catch of marked fish taken by sport fishermen over the next 4 years. Some marked fish were not measured and some fish with clipped fins were not recorded as having been marked. This table includes only fish that were recorded as marked.

Length Class, Inches	Numbers of Marked Bass in 1946 Stocking	Numbers of Marked Bass Observed			
		1947	1948	1949	1950
3.0	828				
3.5					
4.0					
4.5					
5.0					
5.5	1,397				
6.0					
6.5					
7.0					
7.5			1		
8.0	1,397		2		
8.5					
9.0			1		
9.5			1		
10.0			1		1
10.5	23		2		..
11.0		5	11	2	2
11.5		1	14	2	..
12.0			26	1	..
12.5			24	3	..
13.0	23		25	10	..
13.5			18	19	3
14.0			8	18	4
14.5			8	20	..
15.0			4	17	8
15.5	2		..	8	5
16.0			2	9	10
16.5			..	2	3
17.0			..	2	6
17.5			..	..	4
18.0	2		..	..	3
18.5			..	..	2
19.0			1		
19.5			..		1
20.0			2		
20.5					
21.0					
21.5					
22.0					
Total	2,248	6	151	113	52

by sportsmen in 1948–1950 (Table 20) indicate that fin-clipped bass placed in the lake at lengths of 3–11 inches were caught at lengths of 10–16 inches in 1948, 11–17 inches in 1949, and 13.5–18 inches in 1950.

The number of bass used in the 1940 stocking (70 individuals) was too small to have much direct influence on the fishing in 1942–1946. The number of bass used in the 1946 stocking (2,248 individuals) was large enough and the growth of these fish was rapid enough to contribute significantly to the catch, especially in 1948 and 1949.

Growth of Bass in New Broods

While most bass hatched at Lake Glendale in 1940 grew quite slowly, scale examinations showed that some individuals—the so-called cannibals—from the 1940 brood and a smaller number from the 1941 brood grew rapidly. By the spring of 1942, after only two growing seasons, the cannibals had reached lengths of 10–15.5 inches (Tables 14 and 21). By the spring of 1943, the cannibals measured 11.5–18 inches, while most of their slow-growing brood mates measured only 7–10 inches. Scales examined from large bass caught in hoop nets in March, 1942, indicate that the bass of 18.5–19 inches caught by anglers in 1942 (Table 14) were fast-growing individuals of the original stock, rather than cannibals.

At the time of the 1946 population census, 21 cannibals from the 1940 brood measured 17.8–21.6 inches, 10 cannibals from the 1941 brood measured 17.1–21.0 inches, and 1 cannibal from the 1943 brood measured 17.1 inches. Measurements of these fish are included in Table 22. The large bass included in this table as members of the 1939 brood were either individuals from the unplanned stocking of 1941 or were members of the 1940 brood that had formed false annuli. Large bass included as members of the 1938 brood might have come from either the 1940 or the 1941 introductions.

Cannibals measuring 10–14 inches in length made up part of the bass harvest in 1948 (curve B and part of curve C in Fig. 7), but most of the harvest in that year was derived from the fast-growing original stock of 1946 (curve A and the greater part of curve C). Undoubtedly, some cannibals were caught in 1949 and 1950, but the extent of their contribution to the harvest in those years cannot be determined.

As a result of the poor growth of most of the bass hatched in Lake Glendale in 1940–1946 and the small number of cannibals in broods other than those of 1940 and 1941, bass of 11–17 inches were scarce in 1944–1946. This scarcity is shown by the sizes of bass caught by test fishermen (Table 13) and by other fishermen (Table 14), and by the sizes of bass in hoop-net samples (Table 21).

Of the 6,861 bass in the 1946 population census (Table 26), 6,784 measured 3–12 inches, 3 measured 12.5–17 inches, and 74 measured 17.5–23.5 inches; of the fish of 12 inches and smaller, not more than 20 are estimated to have been longer than 11 inches.

Evidence from scale examination is that an exceptionally large brood of bass was produced in Lake Glendale in the first spawning season after each stocking, that is, in 1940 and 1947, that the lake became overstocked by these first bass broods, and that the overstocked condition was maintained through natural reproduction in subsequent years. The major part of each brood was at least slightly stunted. Apparently, most of the slow-growing members of the 1940 and 1941 broods died in the lake, or were caught by fishermen, without reaching lengths much above 10 inches. Fishing in the years 1943–1946 and 1949–1950 would certainly have been better if bass reproduction had been less successful.

The slow growth of most individuals of the 1940, 1941, and 1942 broods is suggested by the absence of significant shifts in modes in the length-frequency

distributions of bass under 10 inches collected in hoop nets in March, 1943–1945 (Table 21) and also by scale examinations. In March, 1944, hoop-net samples, the noncannibal bass of the 1940 brood (represented by 11 fish) averaged 10.2 inches after four growing seasons; those of the 1941 brood (6 fish) averaged 9.2 inches after three

growing seasons; and those of the 1942 brood (7 fish) averaged 8.1 inches after two growing seasons (these data not in tables).

Approximately the same degree of stunting was observed in broods spawned after the 1946 stocking. Length data and scale samples collected from noncannibal bass at the

Table 21.—Size distribution of largemouth bass taken in early spring hoop-net collections at Lake Glendale. Sampling was carried on for 2, 3, or 4 successive days in April, 1941, and in March of subsequent years, with six 1-inch-square mesh hoop nets raised each day of the sampling period (except as noted below). Numbers of net-days are shown in parentheses below the years. An asterisk (*) following a number in the table indicates fin-clipped bass of the 1946 stocking. Bass proved difficult to catch in the nets from 1946 on.

Length Class, Inches	First Period						Second Period			
	1941 (32)†	1942 (16)‡	1943 (20)	1944 (12)	1945 (18)	1946 (12)	1947 (18)	1948 (24)	1949 (18)	1950 (18)
4.0									1	
4.5										
5.0							1*	2		
5.5	1							2		
6.0	..	1	1					3		
6.5	..	6	..					6		
7.0	1	7	1					6		
7.5	..	3	9	1	1			4		
8.0	..	4	22	4	2			4	1	
8.5	..	1	30	6	7			..		
9.0	..	2	23	16	26	1		..	4	
9.5	1	1	2	9	18			..	1	2
10.0		5	2	7	5			1*		
10.5		1	..	4	1			4*	1	1
11.0		..	2	1	2			2*	1	
11.5		3	3	1	..			..	..	
12.0		4	3	1	..			1*	..	
12.5		5	1	2	..			..	..	
13.0		2	5	1	..			1*	..	
13.5		5	5	1	..					
14.0		11	..	1	..					
14.5		2	3	..	..					
15.0		2	4	..	..					
15.5		2	2	..	..				1*	
16.0		..	10	1	1				1*	
16.5		..	6	..	..					
17.0		..	8	1	1					
17.5		1	5	..	..					
18.0		1	3	..	..					
18.5		2	2	1	1					
19.0		1	..	1	1					
19.5			1	1	1					
20.0			3	..	..					
20.5			1	..	..					
21.0			3	1	1					
Total	3	72	160	67	63	1	1	36	11	3

* Fin-clipped bass of the 1946 stocking.
† Eight hoop nets set on April 18, raised on April 20, 21, and 22
‡ Eight hoop nets set on March 11, raised on March 12 and 14.

time of the October, 1950, population census showed that the 1947 brood (represented by 53 fish) averaged 10.3 inches after four growing seasons; the 1948 brood (10 fish) averaged 9.0 inches after three growing seasons; and the 1949 brood (12 fish) averaged 7.5 inches after two growing seasons.

Large numbers of stunted bass were caught, thrown back in the water, and perhaps recaught by sport fishermen. A sharp drop in the number of bass reported by sportsmen as having been thrown back (from 9,369 in 1942 to 3,397 in 1943, Table 15) suggests either (i) that small bass were harder to catch in 1943 than the year before (an

unlikely possibility); (ii) that the number of bass reported thrown back in 1943 was considerably below the actual number (the questioning of fishermen as to the number of fish thrown back was done by technically untrained census takers, but there is no reason to believe that the figures for 1943 were less reliable than the figures for 1942); or (iii) that a considerable number of the 1940 brood died during their third or fourth year of life. Hook injury would seem to have been one of the more likely causes of death.

Although the data suggest a substantial die-off in the 1940 brood at Lake Glendale during the third or fourth

Table 22.—Size distribution of largemouth bass of various ages taken at Lake Glendale during population census in the fall of 1946. The representation of broods shown below resulted from age determinations made from a random sampling of scales of fish of large, small, and intermediate sizes. The bass population was made up mainly of fish less than 10 inches long (Table 27).

Length Class, Inches	Year Hatched (Brood)									
	1946	1945	1944	1943	1942	1941	1940	1939	1938	
5 5	1									
6 0										
6 5										
7 0										
7 5		2								
8 0										
8 5			2	1						
9 0			2	1	1					
9 5			2	2	..					
10 0			2	2	..					
10 5				2	2					
11 0				..	..	2				
11 5				..	..	..				
12 0				..	..	..				
12 5				..	..	..				
13 0				..	..	1				
13 5				..	..	..				
14 0				..	..	..				
14 5				..	1	..	1			
15 0				..	..	..	..			
15 5				..	..	..	..			
16 0				..	..	..	..			
16 5				..	..	..	..			
17 0				1	..	1	..			
17 5				..	2	..	..	2		
18 0				..	1	..	4	1		
18 5				..	..	..	2	1	1	
19 0				..	2	2	2	2	1	
19 5				..	2	3	3	1	..	
20 0				..	..	3	1	1	..	
20 5				..	..	4	1	1	1	
21 0				..	2	2	3	..	..	
21.5				..	..	1	1	1	1	

year of life, length measurements and scales of captured fish failed to indicate a noticeable acceleration of growth rates in surviving members of the brood.

There was no indication that slow-growing bass of the 1947 brood suffered a die-off of the apparent magnitude described for the 1940 brood.

Scale examinations indicated that most of the stunted bass of the 1940 brood that survived the fourth year of life disappeared in their fifth or sixth year (by the spring of 1946) without reaching lengths much greater than 10 inches. Among bass measuring 7–10 inches taken in seine hauls on April 3–5, 1946 (bass having scales with readable age rings), there were 2 from each of the three oldest broods (1940, 1941, and 1942 broods), 6 from the 1943 brood, and 19 from the 1944 brood.

Williamson & Churchill (1948:1) noted a short life span (4 years or less) for most bass in Punch Lake, a Wisconsin lake in which the growth rate of bass was slow compared with that in most lakes in the Midwest for which growth data are available.

Severe stunting of largemouth bass was observed at Larry Lake, Wisconsin, where the bass failed to reach an average length of 10 inches in 5 years (Bennett 1938:168), and at Cowan's Gap Dam, Pennsylvania (Miller & Buss 1960:3), where the bass required an average of 8 years to reach 10 inches.

Jenkins & Hall (1953:26) observed that growth of largemouth bass in new bodies of water in Oklahoma (except in large reservoirs) was much more rapid during the first 2 years than afterward. Up to the third or fourth year of impoundment, bass reached a length of 10 inches within two growing seasons, but later took 3 or 4 years to reach that length. Jenkins & Hall attributed the slowing down in bass growth to competition between bass and other species rather than to overabundance of bass.

An entirely different pattern of large-mouth growth in a new lake was described at Norris Reservoir, Tennessee (Stroud 1948:57–62), where all broods produced during the first 9 years reached average lengths of 10.3–13.0 inches by the end of the second year of life.

The growth in new bass broods at Pounds Lake differed from that at Lake Glendale. Most of the bass spawned in 1940 at Pounds Lake grew at normal rates. There was little evidence of stunting. Cannibals measuring 11–15 inches in 1942 and 11–18 inches in 1943 were caught in hoop-net

Table 23.—Size distribution of largemouth bass caught in 1-inch-square mesh hoop nets at Pounds Lake in March, 1942, March, 1943, and October, 1947. The numbers of net-days are shown in parentheses below the years. The 1947 catch was made after most of the water had been drained from the lake. The March collections of both years were made during the week following the hoop net collections at Lake Glendale.

<i>Length Class, Inches</i>	<i>1942 (10)</i>	<i>1943 (16)</i>	<i>1947 (6)</i>
5.5			1
6.0	2		5
6.5	57		..
7.0	35		..
7.5	4		..
8.0	4		..
8.5	1		5
9.0	..	2	4
9.5	3	3	..
10.0	1	14	..
10.5	2	13	6
11.0	..	7	1
11.5	..	6	3
12.0	1	1	1
12.5	..	..	1
13.0	..	1	..
13.5	1		..
14.0	2	1	..
14.5	1	..	..
15.0	3	..	1
15.5	1	..	..
16.0			..
16.5		1	..
17.0		..	..
17.5		..	..
18.0		..	..
18.5		..	..
19.0		1	..
<i>Total</i>	<i>118</i>	<i>50</i>	<i>28</i>

Table 24.—Size distribution of bluegills taken in early spring hoop-net collections at Lake Glendale. Sampling was carried on for 2, 3, or 4 successive days in April, 1941, and in March of subsequent years, with six 1-inch-square mesh hoop nets raised each day of the sampling period (except as noted below). The numbers of net-days are shown in parentheses below the years. An asterisk (*) following a number in the table indicates fin-clipped bluegills of the 1946 stocking.

Length Class, Inches	First Period						Second Period			
	1941 (32)†	1942 (16)‡	1943 (20)	1944 (12)	1945 (18)	1946 (12)	1947 (18)	1948 (24)	1949 (18)	1950 (18)
3.5	1							2	2	
4.0	2		1		1			1	19	
4.5	6		10	2	3			..	21	
5.0	6	1	50	7	5	4		..	37	2
5.5	1	2	63	66	27	11	2*	..	73	10
6.0	1	13	142	216	174	38	6*	..	71	23
6.5	..	50	268	298	315	89	15*	..	65	24
7.0	..	73	156	288	501	149	17*	6*	27	41
7.5	..	161	91	89	62	103	10*	21*	1	16**
8.0	..	96	38	27	6	7		34*	17*	1*
8.5	1	7	3	1				4*	9*	1*
9.0		2						1*		
9.5		..								
10.0		1								
Total measured	18	406	822	922	1,094	401	50	69	342	118
Not measured	..	468	677	..	238	..	..	..	..	..
Total catch	18	874	1,499	922	1,332	401	50	69	342	118

† Eight hoop nets set on April 18, raised on April 20, 21, and 22.

‡ Eight hoop nets set on March 11, raised on March 12 and 14.

* Fin-clipped bluegills of the 1946 stocking.

** Only one of these 16 fish was fin-clipped.

collections in both lakes (Tables 21 and 23), but many more cannibals were caught in Lake Glendale than in Pounds Lake.

Growth of Original Bluegills

The bluegills placed in Lake Glendale in 1940 and 1946, like the original bass, grew rapidly. A few bluegills of the first stocking (4–7 inches at time of stocking) had reached lengths of 8.5–10 inches when trapped in hoop nets in March, 1942 (Table 24). Bluegills of the second stocking (2–7.5 inches at time of stocking) measured 7–9 inches in length when taken in hoop nets in March, 1948.

The sizes of the fin-clipped originals and of new generations of bluegills caught by the test fishermen (Table 18) suggest that all bluegills in the small 1947 harvest and most of the bluegills of usable sizes in the small

Table 25.—Size distribution of bluegills caught in 1-inch-square mesh hoop nets at Pounds Lake, March 17 and 18, 1942, March 24 and 25, 1943, and October 8 and 9, 1947. The numbers of net-days are shown in parentheses below the years.

Length Class, Inches	1942 (10)	1943 (16)	1947 (6)
3.5			4
4.0	1	2	6
4.5	..	4	5
5.0	1	11	15
5.5	2	24	17
6.0	8	21	32
6.5	25	22	24
7.0	57	17	26
7.5	75	19	42
8.0	28	38	34
8.5	..	10	3
9.0	1		
Total	198	168	208

1948 harvest were from the original stock. The relative scarcity of fin-clipped bluegills measuring 6 inches or longer in the catch of the test fisher-

men after 1948 (Table 18), the relative scarcity of fin-clipped bluegills of these sizes in hoop-net samples after 1948 (Table 24), and a sharp drop in average weights of bluegills from 1948 to 1949 (Table 17) are indications that by 1949 only a small part of the bluegill harvest was coming from the original stock and that few bluegills of the original stock were caught in 1950. It is estimated from the frequency of fin-clipped bluegills of usable sizes in the hoop-net samples that only about 15 per cent of the bluegills of the 1946 stock were harvested. From Fig. 7, it is estimated that about 40 per cent of the bass of the 1946 stock were harvested.

Growth of Bluegills in New Broods

The descendants of the bluegills placed in Lake Glendale and Pounds Lake in 1940 grew rapidly enough to maintain a constant supply of harvestable-size fish in 1942–1946. Sampling with hoop nets (Tables 24 and 25) indicated that the majority of the bluegills spawned at Lake Glendale and at Pounds Lake in 1940 reached the desirable length of 7 inches in two growing seasons. The descendants of the bluegills placed in Lake Glendale in 1946 grew less rapidly and did not contribute much to the bluegill harvest in numbers until 1950. Whereas the March, 1942, hoop-net catch showed bluegills of the 1940 brood to be most abundant in the 6.5–8-inch classes, the March, 1949, hoop-net catch showed bluegills of the 1947 brood to be most abundant in the 5.5–6.5-inch classes (Table 24).

CENSUS OF POPULATION AND STANDING CROP

The number of largemouth bass in the 1946 and 1950 censuses at Lake Glendale and the number of bluegills, warmouths, and green sunfish in the 1946 census are shown in Table 26. Bass measuring 10 inches or larger were more than three times as abun-

dant in the 1950 census as in the 1946 census (Table 27). However, in both censuses the great majority of the usable-size bass (10 inches or longer) measured less than 11 inches. The terminal population of bass measuring 12.5 inches or longer is placed at 77 individuals (actual count) for the entire lake in October, 1946, and at 133 individuals (count and estimate combined) in October, 1950.

Three to 3.7 times as many largemouth bass, 3.9 times as many bluegills, and 5.6 times as many warmouths of harvestable sizes were found in the population censuses as were taken by anglers during the fishing seasons immediately preceding the censuses (Table 27). Comparable figures for the unfertilized Dixon Springs ponds were slightly lower for bass, and the same or higher for bluegills (Hansen et al. 1960:381). The fish recovered at the end of the 1946 and 1950 seasons at Lake Glendale must have included some that had grown to harvestable sizes during the season. It therefore should not be assumed that the harvestable population at the beginning of each season was the sum of the number observed in the census and the number taken out by fishermen.

While the rotenone treatments in the fall of 1946 did not kill all of the green sunfish, the low census count for these fish may be an indication of a population decline that was evident in the angling data for the years 1942–1946 (Table 6).

A great many observations on standing crop, or the total weight of all fish present in a body of water, have been published over the past three decades. Data on both standing crop and yield to anglers from the same water have been scarce, and some of the available data lend little backing to the supposed correlation between fish abundance and fishing success (Bennett 1954:262; Hansen et al. 1960:380).

In the fall of 1946, Lake Glendale had a terminal population or standing

crop of about 86 pounds per acre (Table 26). This terminal population figure did not include fish less than 2 inches long. The number of pounds per acre was as follows: bass 19 pounds, bluegills 62 pounds, warmouths 4 pounds, green sunfish less than 1 pound. The total number of fish of all species (exclusive of 2-inch and smaller fish) came to 37,190 fish (Table 26).

The standing crop of bass in Lake Glendale in 1950 was approximately 23 pounds per acre, or about 4 pounds per acre more than the terminal population of bass in the fall of 1946 (Table 26). Under various programs of stocking at Ridge Lake, the standing crop values for largemouth bass observed at 2-year intervals, 1943-1951, ranged

from about 32 to about 50 pounds per acre (Bennett 1954:244). Ridge Lake was originally stocked in 1941 with 435 largemouth bass, or 24 per acre; in 5 census years, the number of bass returned to the lake after the censuses ranged from 22 to 110 per acre (Bennett 1954:236, 240).

The 1946 standing crop value for Lake Glendale was considerably below the published values for six of eight small ponds in the same region (Table 28); it was slightly higher than the values for two of them. No explanation has been found for the fact that the standing crop values for these two ponds were so much lower than the values for the other six. In addition to the possibility that there were actual

Table 26.—Population censuses of largemouth bass and other sunfish in Lake Glendale (fish 2 inches and larger) in the fall of 1946 and estimated population of largemouth bass in the fall of 1950. Only bass were censused in 1950. The 1946 census included fish captured by draining combined with those recovered by rotenone treatment of water remaining in the lake bed. The 1950 census included bass removed from the lake, mainly by draining, combined with a mark-and-recovery estimate of those remaining after most of the water had been drained off.

Year	Kind of Fish*	Total Number	Total Weight, Pounds	Standing Crop, Pounds Per Acre
1946	Largemouth bass	6,861	1,533	18.7
	Bluegill	27,763	5,102	62.2
	Warmouth	2,327	350	4.3
	Green sunfish	239	29	0.3
	Total	37,190	7,014	85.5

1950	Largemouth bass†	4,379	1,865	22.7

* In addition to the four species named in the table, the 1946 census included the following: 3 bluegill × green sunfish hybrids, 1 longear sunfish, 5 European carp, 17 golden shiners, 14 black bullheads.

† Data from Table 2.

Table 27.—Numbers of fish kept by anglers in 1946 and 1950 in relation to numbers of fish of harvestable sizes present at Lake Glendale in the 1946 and 1950 fall censuses.

		Fish in Population Censuses				Ratio: Number of Fish of Harvestable Sizes in Census to Number Kept by Anglers
Year	Kind of Fish	Total Population (Fish 2 Inches or Longer)	Fish of Harvestable Sizes*		Number of Fish Kept by Anglers in Year of Census	
1946	Largemouth bass	6,861	418†	5	137	3.0:1
	Bluegill	27,763	21,316	260	5,461	3.9:1
	Warmouth	2,327	1,332	16	237	5.6:1
	Green sunfish	239	103	1	150	...

1950	Largemouth bass	4,379	1,377†	17	375	3.7:1

* Harvestable sizes: largemouth bass, 10 inches and longer; other species, 6 inches and longer.

† Seventy-seven of the 418 bass in the 1946 census and 133 (estimated) of the 1,390 bass in the 1950 census were 12.5 inches or longer.

differences in productivity of these waters is the possibility that the extent of recovery of dead fish was not the same in all ponds. Carlander & Lewis (1948:135-136) demonstrated that not all fish killed by rotenone were recovered from a small pond and that the rate of recovery differed among fish species. They pointed out that pond conditions influence the rate of recovery.

Of the eight ponds represented in Table 28, seven are located in the two southernmost tiers of counties in Illinois, while one is located in northwestern Kentucky. The three Pope County ponds are not more than 2 miles from Lake Glendale. The standing crop value for Lake Glendale was much lower than the values for these three ponds.

The stocking rates (fish per acre) used in the three Pope County ponds were much greater than the rates used in Lake Glendale in 1940: 0.9 bass and 2.6 bluegills per acre in Lake Glendale, 36 bass and 412 bluegills in Wells Pond, 30 bass and 396 bluegills in Boaz Pond, and 21 bass and 310 bluegills in Elam Pond (Hansen et al. 1960:353). The standing crop values for the three ponds were based on censuses made with rotenone 7 years after the ponds were stocked. The stocking rates in the other ponds included in Table 28 are not known. The census of JP-1 was made 5.5 years after the pond was stocked (Turner 1959:7).

Lake Glendale not only had a much lower standing crop value than the three Pope County ponds, it contained fewer fish of harvestable sizes per acre: 5 bass and 260 bluegills per acre in 1946 and 17 bass per acre in 1950 (Table 27). The three Pope County ponds contained 24-59 harvestable-size bass per acre and 442-624 harvestable-size bluegills per acre (Hansen et al. 1960:378).

The finding that Lake Glendale had a much lower standing crop value than the three unfertilized ponds at Dixon

Springs is in agreement with the findings of Rounsefell (1946:32-35) for United States and Canadian lakes and of Carlander (1955:550) for Alabama ponds, namely that the number of pounds of fish per acre drops (is negatively correlated) with increase in water area. It is not in agreement with the analysis by Carlander (1955:550) of midwest ponds (drained and undrained ponds considered together) nor with Carlander's final conclusion that "the available data show no significant correlation between standing crop and area of the body of water."

The fact that the standing crop value for Lake Glendale was much below that of the nearby Wells, Boaz, and Elam ponds is of special significance in that these waters are similar in ways that might be expected to affect standing crop. Lake Glendale and the three ponds had been built at about the same time, in the period 1935-1940, and had been stocked 6 to 7 years at the time of the standing crop observations. The composition of fish species included mainly centrarchids: largemouth bass and bluegills in the ponds; largemouth bass, bluegills, warmouths, green sunfish, and only a few individuals of other families in Lake Glendale. All of these waters are soft and, because of similar soils on their watersheds, are probably similar in chemical composition. Of uncertain importance are the differences between the ponds and Lake Glendale in the soil treatments of their watersheds. The fields draining into the ponds had been periodically treated with crushed limestone and fertilizers of various kinds. Probably little if any of the land draining into Lake Glendale had received lime or chemical fertilizer treatment. Undoubtedly, some of the fertilizers applied to the watersheds were washed into the ponds, but whether in sufficient amounts to affect the standing crops materially is open to question. Hansen et al. (1960:384-385) were unable to establish clearly that fertilizer

applications to the watersheds of the ponds affected fishing success in the years of application.

No inverse relationship between standing crop and water area was found when Lake Glendale was compared with two of the eight small ponds included in Table 28, namely Waltonian and JP-1. The fact that the standing crop values for these two ponds were so much lower than standing crop values for other ponds of similar size in the region suggests that these two ponds may not have been typical.

FACTORS THAT DETERMINE FISHING EFFORT

There was little evidence of a close relationship between fishing effort (man-days of fishing per year) and fishing success at Lake Glendale, and the reasons are only partly understood. The relatively intensive fishing in 1942 can be explained by the likelihood that many fishermen were anxious to try out the new lake, by the exceptionally good bass fishing that occurred on the first day of the season, and by fairly good bluegill fishing during the first season. Part or all of the increase in fishing in 1946 may have been due to the return of servicemen to civilian life following World War II. The scarcity of fishermen in 1947 can be accounted for in part by the extremely poor bluegill fishing and in part by the probability that some potential fishermen assumed that the lake was closed in that year, following the draining and restocking of 1946. The sharp increase in fishing in 1948 was probably due to marked improvement in the success of bass fishermen (Table 10).

Of some interest is the fact that, although the Lake Glendale Recreation Area offered fishing for the whole family, at least 89 per cent of the fishing was done by fishermen 18 years of age or older who had purchased licenses (Table 5).

In Michigan, Lagler & De Roth

(1953:246) found a relationship between angler attitude (that is, fishing effort), fishing success, and population of legal-size bass in the Loch Alpine ponds, a pair of connected, privately owned ponds near Ann Arbor, Michigan. In 1950, when the population level in Lower Loch Alpine was approximately 17 legal-size largemouth bass per acre, the catch averaged 0.25 keeper bass per fisherman hour. In 1951, when the population in Upper Loch Alpine approximated 6 legal-size bass per acre, the catch was 0.04 legal-size bass per fisherman hour. By mid-summer of 1951, the interest in fishing Upper Loch Alpine pond had "waned completely" because fishermen concluded that the pond had been "fished out."

The response of bass fishermen to poor fishing at Lake Glendale was unlike that observed by Lagler & De Roth in Michigan. Creel records and conversations with anglers at Lake Glendale gave no indication that bass fishermen using casting rods and plugs were discouraged in 1946 when their catch of legal-size bass was only 0.06 per trip (Table 10) or about 0.01 fish per hour, and the population of legal-size bass in the lake at the end of the season was only about 5 per acre (Table 27).

An examination of Table 10 will show that although plug fishing at Lake Glendale was carried on most intensively in the years of highest catch rates (1948-1950), there were year-to-year changes in the fishing effort (amount of plug fishing) that cannot be explained entirely by changes in fishing success. For example, a steady increase in number of fishing trips per season occurred in the years 1944-1946, a period in which the catch per trip was declining. The fishing effort by plug fishermen in 1946, a year in which many servicemen were returning to civilian life, was more than twice as heavy as in 1944, and yet the harvest per trip by these fishermen in 1946 was only about a third of that in 1944.

Improvement in success of plug fishermen at Lake Glendale did not result in a corresponding increase in fishing effort. In 1950, a year in which the harvest per trip by sportsmen using casting rod lures was six times by number of fish, three times by weight of fish, the comparable figures for 1946 (Table 10), the number of trips by these sportsmen was less than a third more than the number in 1946 (Table 10). The population of legal-size bass was approximately 17 per acre in 1950 and 5 per acre in 1946 (Table 27).

Either bass fishermen at Lake Glendale were not very sensitive to changes in their own fishing success or factors other than catch rate had a strong effect on fishing effort. One explanation for differences between Lake Glendale and Loch Alpine fishermen in their reactions to poor fishing may be that most anglers who fish in public waters are more tolerant of poor fishing than anglers who fish in privately owned lakes. Perhaps the fishermen in public waters have fewer opportunities to learn the truth about the quality of angling in the waters they fish. The anglers who fish in privately owned waters may get dependable catch information from the record books, from caretakers, or from fellow anglers. Anglers who fish in public lakes usually do not have access to creel records (ready access to these records was not provided at Lake Glendale). They may get catch information from other fishermen, but the information may be less reliable or less detailed than the information available to anglers at club-owned or other privately-owned lakes. The concessionaires at public lakes are not always willing to report poor fishing.

Below are some reasons that year-to-year fishing effort on any one lake may not be closely correlated with fishing success.

1. Many fishermen are unable to detect in their own fishing, or in the fishing of others, year-to-year differences

in fishing success that may appear significant to fisheries students.

2. Some fishermen detect year-to-year or week-to-week differences in their success but for various reasons do not react to them. For example, even when they know that fishing is poor they may continue to fish.

3. The total fishing effort on a lake in any one year may be affected by exceptionally good or bad weather, especially if this abnormal weather occurs in spring when fishing is usually heaviest.

4. The fishing effort is likely to vary as the number of potential fishermen varies. For example, an influx of workmen into the surrounding territory may occur in one year and these workmen may be gone the following year.

5. Fishing effort is likely to be affected by national upsets—war, business booms, and depressions.

6. Fishing effort on a lake may be affected by a change in fishing success on neighboring lakes.

7. The interest in a lake aroused by exceptionally good fishing in one year may carry over into several later years, or lack of interest resulting from poor fishing in 1 or more years may result in reduced fishing effort for several succeeding years.

8. News that fishing is good or has improved may travel faster and more widely and thereby affect more people than news that fishing success has dropped off. Only good fishing or a change for the better has much chance of being reported by the news media.

9. In poor fishing years, business people may attempt to revive the interest of fishermen by launching fishing contests or by advertising the capture of exceptionally good strings of fish or the capture of one or more fish of exceptional size.

10. Some fishing effort comes from anglers who are aware that fishing for large fish is poor but are satisfied by captures of small fish.

11. Even though fishing is poor, some anglers fish the same lake year after year because they find it aesthetically satisfying, because they find it convenient, because they like the boats or the sociability of certain lakeshore establishments, or because they do not know where their chances of success may be better.

12. Some fishing is done by anglers who assume that big fish must be present where many small fish are present.

13. Some fishing is done by persistent anglers who believe that fishing success is most apt to come to those who fish hard or often.

14. Presumably, more fishermen of exceptional ability are present in years of good harvests than in years of mediocre or poor harvests.

15. To some extent the fishing effort, like the size of crowds at some sports events, results from factors that are unpredictable and unexplainable.

DISCUSSION

The heavier stocking of Lake Glendale with largemouth bass and bluegills in 1946 (27.4 young and adult bass and 41.3 young and adult bluegills per acre) had several advantages over the lighter stocking in 1940 (0.9 adult bass and 2.6 adult bluegills per acre): (i) It provided a larger population of harvestable-size bass while the offspring of the original stock were too small to harvest. (ii) It resulted in a much better population of 12-inch and longer bass—sizes that please bass fishermen. (iii) It did not necessitate closing of the lake while a new brood of fish was growing to harvestable sizes, since harvestable-size bass were recruited quickly in 1947 from among the 7–9 inch bass used in the 1946 stocking. But the heavy stocking in 1946 was disappointing in several respects: (i) Most of the stock bass, which grew rapidly into fish of 12 inches or longer, had been caught or had died from natural causes by the end of 1949 and had been replaced by other fish, most of

which were less than 12 inches in length. (ii) The number of bass in the 1946 stocking, although much larger than the number in the 1940 stocking, did not provide adequate control over their own young. Thus, except for occasional cannibals among the young bass, the new broods of bass produced in 1947 and later were as stunted as those produced after the 1940 stocking. (iii) The number of stock bluegills caught by anglers was small. (iv) The first bluegill brood spawned after the heavy stocking took 2 years longer to reach desirable angling sizes than the first brood of bluegills spawned after the 1940 stocking.

The outcome of stocking 1-acre ponds near Lake Glendale with 1-inch fingerling bluegills at the rate of 310 to 412 per acre and 6-inch to 10-inch largemouth bass at the rate of 21 to 36 per acre suggests the potential value of a similar stocking in Lake Glendale. However, the standing crops in the ponds were well above the standing crops in Lake Glendale (Table 28), indicating much greater fertility of the ponds. Because of the lower fertility of Lake Glendale, the best stocking rates for this lake might be much lower in number of fish per acre than the stocking rates for the ponds. This statement assumes the probability that the number of fish that will grow from fingerling to adult size in a given period will vary from lake to lake with fertility of the water. Fisheries biologists have seldom attempted to adjust the stocking rate to water fertility except in ponds that are to be fertilized.

The good growth of bluegills hatched in Lake Glendale in 1940 when only 2.6 adult bluegills per acre were used in the stocking may have resulted from a chance factor—that the “right” number of young bluegills was produced or that the “right” number survived. The small number of spawners was probably one of the factors; hatching success, disease, and the degree of thinning of the new bluegill brood the

Table 28.—Standing crops of fish in Lake Glendale and in various small ponds in southern Illinois and in one pond in northwest Kentucky. The stocking procedures are known for only the first four waters listed.

Body of Water	County and State	Surface Area, Acres	Species of Fish Present*	Standing Crop, Pounds Per Acre	Authority
Lake Glendale (1946)	Pope, Illinois	82	Lm, Bg, Gr, Wm	86	Hansen (present paper)
Wells Pond†	Pope, Illinois	0.5	Lm, Bg	237	Hansen et al. (1960:378)
Boaz Pond†	Pope, Illinois	0.75	Lm, Bg	308	Hansen, et al. (1960:378)
Elam Pond†	Pope, Illinois	1.25	Lm, Bg	169	Hansen et al. (1960:378)
Waltonian Pond	Saline, Illinois	1	Lm, Bg, Gr	71	Bennett (1943:361)
Delta Pond	Union, Illinois	0.8	Lm, Bg, Wm, Wc	234	Bennett (1943:361)
Upper Lamer Pond	Jackson, Illinois	0.25	Lm, Bg, Gr, Wm, Wc	516	Elder & Lewis (1955:390-392)
Lower Lamer Pond	Jackson, Illinois	0.5	Lm, Bg, Gr, Wm, Wc	285	Elder & Lewis (1955:390-392)
JP-1 Pond	McCracken, Kentucky	0.5	Lm, Bg, Wc	73	Turner (1959:7)

* Lm = largemouth bass, Bg = bluegill, Gr = green sunfish, Wm = white crappie.
† Standing crops in Wells, Boaz, and Elam ponds were observed after prolonged drought. The standing crops for these lakes were computed from the reduced areas shown in this table.

first year by the new brood of bass or other predators were possible factors.

Although the early results of the 1946 stocking at Lake Glendale differed from those of the 1940 stocking, there are indications in the year-to-year trends in fishing success that the final outcome of the 1946 stocking might have been approaching that of the 1940 stocking, that is, good or moderately good bluegill fishing but poor bass fishing.

The stocking tests reported here suggest the possibility that some lakes might be stocked for the special benefit of bass fishermen and others for the special benefit of bluegill fishermen. These tests also suggest greater promise for long periods of good bluegill fishing than for long periods of good bass fishing.

There seems to be no question that more bass measuring 12 inches and larger were caught and removed by Lake Glendale fishermen in 1948 than could be replaced by growth in a single season or in several seasons without adequate thinning of numbers of the smaller bass; nor is there much question that heavy removal of large bass was the main reason for the decline in bass harvest and catch rate from 1948 to 1949 and the further decline from 1949 to 1950.

There is some possibility that the good bass fishing observed at Lake Glendale in 1948 might have continued for several more years if the rate of stocking in 1946 had been a little heavier, and if the removal of the fast-growing original stock bass by fishermen had been severely restricted. It is, of course, possible that a low daily limit would have resulted only in a greater number of fishing trips and no reduction in harvest. Some loss of the original stock would have occurred from natural causes and probably there would have been losses from hook injuries. Most of the marked 6-inch to 10-inch bass used in stocking the Dixon Springs ponds in 1946 were caught

within 2 years; only a few were caught after 3 years. Very few of the bass hatched in Lake Glendale survived beyond the age of 4 or 5 years, and original stocks might not have lasted longer than 5 years under heavier stocking or under special protection for large bass.

The overpopulation of Lake Glendale with small, slightly stunted bass described here for the periods 1942–1946 and 1947–1950 has continued to be a problem. Natural History Survey test fishermen of the past 15 years have caught few bass more than 11 inches in length, while they have caught many less than 10 inches. There is a possibility that anglers might do an effective job of thinning stunted bass populations in Lake Glendale if they were required to remove all or most of the bass caught. The numbers of small bass removed voluntarily since the 10-inch minimum length limit was dropped in 1951 have probably been small. The possibility that large numbers of small bass could be removed by hook-and-line in a thinning program is shown by the records of numbers of bass caught and thrown back by fishermen in the years 1946 and 1950 (Table 15). The number thrown back by fishermen in 1946 amounted to 30 per cent of the number of bass under 10 inches observed in the 1946 population census, and the number thrown back in 1950 amounted to 54 per cent of the number observed in the 1950 census. The good growth of the small bass of the 1946 stocking can be attributed to the small number of bass put back in the lake—one-third of the number of small bass found in the 1946 census. This rate of stocking was equivalent to removing two-thirds of the stunted population in one operation.

The thinning of stunted fish populations by hook-and-line has often been recommended by fisheries biologists. If thinning by this method is contemplated, the possibilities of both underthinning and overthinning should be

considered. What percentages of small bass of various sizes caught by fishermen should be removed to assure favorable growth of the remaining stunted bass? Is it possible to remove so many stunted bass that the number remaining is too small to provide good fishing at a later date? Might the removal of large numbers of stunted bass decrease predation so much that overpopulation and stunting in new bass broods would still be a problem?

Accurate estimates of the numbers of bass of various size categories present in lakes before thinning is begun are highly desirable but hard to obtain. During the thinning process, records should be kept of the numbers of bass of various sizes removed by fishermen. The success of the operation would be measured by improvement in the yield and in the catch rate of the larger sized fish. Under a program of adequate thinning, benefits should be detected within a year.

SUMMARY

1. The relative success of two stocking procedures used at Lake Glendale was measured in terms of the quality of hook-and-line fishing that followed the stockings. The initial stocking, in the spring of 1940, was done with adult fish at the rate of 0.9 largemouth bass and 2.6 bluegills per acre; the later stocking, in the fall of 1946, was done with a mixture of yearling and adult fish at the rate of 27.4 largemouth bass and 41.3 bluegills per acre. Warmouths and green sunfish contaminated the lake in both study periods, 1940–1946 and 1946–1950, but the populations built up by these species were small.

2. In the fall of 1946, before the second stocking, a population census was made of all species of fish in Lake Glendale. Fish were collected and counted in a draining and censusing operation that included application of rotenone to small areas that could not be drained.

3. In the fall of 1950, a census was made of the largemouth bass population (but not populations of other species) in Lake Glendale. Fish were collected and counted in a draining and censusing operation that included an estimate, by the mark-and-recovery method, of the numbers of fish remaining in the small undrainable areas.

4. The years 1943–1946, after the lighter stocking, were considered good for bluegill fishing but poor for bass fishing. The years 1947–1950, after the heavier stocking, were better than the earlier years for bass fishing but not so good for bluegill fishing.

5. For fishermen not concerned with the kind of fish caught, the first period was better than the second.

6. The annual bluegill yields (by weight) were 4 to 12 times the bass yields during the first study period; they were smaller than bass yields during the first three seasons of the second study period.

7. The light stocking of adult bass and bluegills used at Lake Glendale in 1940 was used in the same year at Pounds Lake (32 acres), in a neighboring county. Fishing was similar in the two lakes during the years 1943–1946, except that Pounds Lake had one season of good bass fishing, whereas Lake Glendale had none in these years.

8. The best harvest of bass at Lake Glendale after the lighter (1940) stocking was in 1942 (279 bass); the best after the heavier (1946) stocking was in 1948 (637 bass).

9. In the first study period (5 years of fishing), the annual rates of bass harvest ranged from 0.06 to 0.14 fish per trip or from 0.7 to 3.4 fish per acre; in the second period (4 years of fishing), they ranged from 0.17 to 0.57 fish per trip, or from 0.9 to 7.8 fish per acre.

10. The bass of the 1940 stock (70 fish) were so few in number that they did not contribute much to the fishing in 1942–1946. The bass of the 1946 stock (2,248 fish) figured prominently in the total bass harvest in the first

three fishing seasons of the second period and contributed heavily to the harvest of large bass throughout the period.

11. In most years, fly rod lures produced the best bass fishing in terms of number of fish harvested per trip; casting rod lures (plugs etc.) produced the best fishing in terms of pounds of fish harvested per trip.

12. In 1942, the first year Lake Glendale was opened to fishing after the 1940 stocking, 40 per cent of the year's harvest of bass was taken on opening day; 75 per cent of the year's harvest of bass was taken during the first 15 days.

13. The average size (pounds) of bass harvested by fishermen was greater in the period of low annual bass harvests (1942–1946) than in the period of better bass harvests (1947–1950).

14. Most bass harvested during the first period (when harvestable-size bass were scarce) were either just above legal size, 10–11 inches, or they were fairly large, 17 inches or larger; those harvested during the second period included not only individuals of small and large sizes but also large numbers of bass of intermediate sizes, 12–16 inches.

15. More small bass were caught and thrown back in the lake during the period of poor bass fishing (1942–1946) than during the period of better bass fishing (1947–1950).

16. In each year of both periods, the percentage of the catch returned to the water was higher for bass than for bluegills.

17. Bluegill catch rates reached a plateau during the fourth growing season of the first period and improved steadily from the first through the fourth growing season of the second period (the last season in which observations were made).

18. As bluegill bait, worms were much better than artificial flies.

19. A drop in the water level of Lake Glendale in the fall of 1944, reducing

the water area 22 per cent, was insufficient to have a significant effect on either the size or the catch rate of bluegills in the following 2 years. Efforts to improve the bass harvest by allowing the use of minnows in 1943, by adding a fall fishing season in 1943, and by adding an early spring season in 1946 were not successful.

20. Bass used in stocking Lake Glendale in 1940 and 1946 grew rapidly and reached large sizes. Most of the bass hatched at Lake Glendale after each stocking grew slowly as a result of overcrowding, but some individuals, the so-called "cannibals," grew rapidly.

21. Evidence from scale examination is that Lake Glendale became overstocked with bass in the first spawning season after each stocking and that the overstocked condition was maintained by reproduction during subsequent spawning seasons. As a result, the major part of each brood was at least slightly stunted. Most of the bass of the 1940 and 1941 broods died in the lake or were caught by fishermen without attaining lengths much above 10 inches.

22. Bluegills of the original stocks, like bass of the original stocks, grew rapidly and attained large sizes.

23. Bluegills of the broods spawned in the lake in 1940, following the lighter stocking, grew rapidly enough to provide fair fishing in 1942; those spawned in 1947, following the heavier stocking,

grew slowly and did not contribute much to the fish harvest until 1950.

24. Three times as many bass, 3.9 times as many bluegills, and 5.6 times as many warmouths of harvestable sizes were taken in the 1946 fall population census as were harvested by fishermen in 1946; 3.7 times as many bass of harvestable sizes were estimated to be present in the fall census of 1950 as were harvested by fishermen in 1950.

25. The standing crop of fish (2 inches and larger) in Lake Glendale in the fall of 1946 was 86 pounds per acre: 19 pounds of largemouth bass, 62 pounds of bluegills, 4 pounds of warmouths, and less than 1 pound of green sunfish. The estimated standing crop of bass in the fall of 1950 was 23 pounds per acre.

26. The standing crop value for Lake Glendale was similar to the standing crop values for two small ponds in the region but considerably below the values of 6 other ponds, including three 1-acre ponds within 2 miles of the lake. Lake Glendale contained fewer fish of harvestable sizes per acre than the three nearby ponds.

27. Bass fishermen at Lake Glendale did not lose their interest in bass fishing when the population of legal-size bass stood at 5 fish per acre and the catch rate on plugs averaged only 0.06 bass per trip. No close correlation was found between fishing effort and fishing success.

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Fish species having names of more than one word are listed with the words in normal rather than inverted order: for example, *Largemouth* bass rather than *Bass*, *largemouth*. Cross references are given only in cases where such listings were believed necessary.

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WILLIAM F. CHILDERS

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Volume 29, Article 3
September, 1967



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This report is printed by authority of the State of Illinois, IRS Ch. 127, Par. 58.12. It is a contribution from the Section of Aquatic Biology of the Illinois Natural History Survey.

(39846—5000—9-67)





F₁ triploid. - A green sunfish x bluegill F₁ hybrid produced by stocking male green sunfish and female bluegills in a pond containing no other fishes. Young-of-the-year F₁ hybrids were removed from the brood pond and stocked in a pond which contained only largemouth bass. When captured the individual was 6 years old, had a total length of 12.2 inches, and weighed 2 pounds, 2 ounces.

Hybridization of Four Species of Sunfishes (Centrarchidae)

WILLIAM F. CHILDERS

HYBRIDIZATION is very common within many genera of plants and has been postulated as an important evolutionary mechanism of speciation in the plant kingdom (Anderson 1953:282-283; Heer 1949:654; Stebbins 1959:248). In the animal kingdom, the evolutionary importance of hybridization is less clear. Hybrids have been reported for most metazoan groups although in only a few cases are they known to be self-perpetuating (Ross 1958:337).

In fishes the incidence of natural hybridization appears to be low. Bailey (1960a:13) estimates that there are between 15,000 and 17,000 Recent fish species, and Slastenenko (1957:76-91) lists only 167 known natural interspecific fish hybrids of the world. Crossman & Buss (1965:1261) suggest the possibility of three additional hybrids in the Esocidae. Approximately 90 percent of these 170 hybrids were found in freshwaters; the rest occurred in marine or brackish water environments. About two-thirds of the freshwater hybrids were found in North America. Hubbs (1955:18-19) pointed out that hybridization has probably been most frequent in North American freshwaters where the existing fish fauna became established only as recently as the Miocene, Pliocene, and Pleistocene epochs. Hubbs also remarked that a considerable body of circumstantial evidence indicated that introgressive hybridization has been a significant factor in speciation in the tribe Lepomini of the Centrarchidae.

The term *hybrid* has been variously defined (Darwin 1897:1-2; Darlington 1958:4; Stebbins 1959:231). Unless otherwise specified, *hybrid*, as used

here, refers to the offspring of inter-specific matings.

ACKNOWLEDGMENTS

This paper is based upon research conducted at the Illinois Natural History Survey. Dr. George W. Bennett, Head of the Aquatic Biology Section, supervised this project and aided in all stages of the study. His advice, help, and encouragement were invaluable.

Most of the results presented in this paper were included in a thesis submitted to the University of Illinois in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Professor Charles S. Kendeigh directed my graduate studies, served as chairman of my doctoral committee, and assisted in the revision of my thesis manuscript.

Drs. Weldon R. Larimore and Donald F. Hansen of the Aquatic Biology Section of the Illinois Natural History Survey aided in part of the field work, criticized the manuscript, and made many valuable suggestions during all stages of this study. Mr. Robert M. Zewadski, Associate Technical Editor of the Survey, edited this paper, and his patience and skill are greatly appreciated. Professor Horace W. Norton of the University of Illinois advised and assisted in the statistical analysis of the data.

I also express my appreciation to my wife, Norma H. Childers, who assisted with laboratory experiments, and to staff members, too numerous to mention individually, of the Illinois Natural History Survey and the University of Illinois who contributed to this study.

Mr. William Utterback of Gibson

City, Mr. and Mrs. G. Maxfield of Fairmount, and Professor Fay H. Root, Assistant Director of Robert Allerton Park, donated the use of numerous ponds. The willing cooperation of these people is greatly appreciated.

THE CENTRARCHIDAE

The Centrarchidae (sunfishes) are a group of freshwater fishes of temperate

North America whose present center of distribution is the Mississippi River basin. A complete classification of the extant Centrarchidae is given in the accompanying list. With one exception all 27 species were originally limited to freshwaters east of the Rocky Mountains. This exception, the Sacramento perch, *Archoplites interruptus* (Girard), is a relict form native to Califor-

Classification of the Centrarchidae. The scientific and common names are those suggested by Bailey (1960b: 27) and the subfamily and tribal classification follows that of Branson & Moore (1962).

Subfamily Centrarchinae

Tribe Ambloplitini

<i>Archoplites interruptus</i> (Girard)	Sacramento perch
<i>Ambloplites cavifrons</i> Cope	Roanoke bass
<i>Ambloplites rupestris</i> (Rafinesque)	Rock bass
<i>Acantharchus pomotis</i> (Baird)	Mud sunfish

Tribe Centrarchini

<i>Pomoxis nigromaculatus</i> (Lesueur)	Black crappie
<i>Pomoxis annularis</i> Rafinesque	White crappie
<i>Centrarchus macropterus</i> (Lacépède)	Flier

Subfamily Lepominae

Tribe Enneacanthini

<i>Enneacanthus obesus</i> (Girard)	Banded sunfish
<i>Enneacanthus gloriosus</i> (Holbrook)	Bluespotted sunfish
<i>Enneacanthus chaetodon</i> (Baird)	Blackbanded sunfish

Tribe Lepomini

<i>Chaenobryttus gulosus</i> (Cuvier) ¹	Warmouth
<i>Lepomis symmetricus</i> Forbes	Bantam sunfish
<i>Lepomis cyanellus</i> Rafinesque ¹	Green sunfish
<i>Lepomis macrochirus</i> Rafinesque ¹	Bluegill
<i>Lepomis humilis</i> (Girard)	Orangespotted sunfish
<i>Lepomis gibbosus</i> (Linnaeus)	Pumpkinseed
<i>Lepomis microlophus</i> (Günther) ¹	Redear sunfish
<i>Lepomis punctatus</i> (Valenciennes)	Spotted sunfish
<i>Lepomis marginatus</i> (Holbrook)	Dollar sunfish
<i>Lepomis auritus</i> (Linnaeus)	Redbreast sunfish
<i>Lepomis megalotis</i> (Rafinesque)	Longear sunfish

Tribe Micropterini

<i>Micropterus salmoides</i> (Lacépède)	Largemouth bass
<i>Micropterus dolomieu</i> Lacépède	Smallmouth bass
<i>Micropterus coosae</i> Hubbs & Bailey	Redeye bass
<i>Micropterus notius</i> Bailey & Hubbs	Suwannee bass
<i>Micropterus punctulatus</i> (Rafinesque)	Spotted bass
<i>Micropterus treculi</i> (Vaillant & Bocourt)	Guadalupe bass

¹Species used in hybridization experiments.

nia. In the last 100 years many species have been widely introduced into freshwaters throughout North America and in other parts of the world.

Lepomini Evolution

On the basis of the fossil record, current natural geographic distribution, and comparative morphology, the evolution of the Lepomini can be hypothesized as follows:

- 1) The Centrarchidae date from the early Cenozoic and are closely related to the sea basses (Serranidae) (Miller 1958:199).
- 2) The Mississippi River basin was probably their center of origin (Branson & Moore 1962:88).
- 3) A relative abundance of extinct centrarchids in Miocene and Pliocene rocks of Oregon, Nevada, and Utah indicates that the Cen-

trarchids' range was much larger then than it is now (Miller 1958: 193, 199).

- 4) The Rocky Mountain uplift, beginning in the Miocene or early Pliocene and increasing to the end of the era (Schuchert & Dunbar 1941:386) isolated west coast Centrarchids from those east of the Rocky Mountains.
- 5) Fossils of the extant species warmouth and black crappie have been found in middle Pliocene deposits in Logan County, Kan. (Branson & Moore 1962:96).
- 6) Late Pliocene to early Pleistocene deposits in southern Idaho and eastern Oregon contain a fossilized sunfish which is probably of the genus *Lepomis* (Miller 1958: 194).
- 7) During the Pleistocene the west

Lepomini hybrids known to occur in nature.

Kind of Hybrid

- Warmouth x Pumpkinseed
- Warmouth x Redbreast sunfish
- Warmouth x Green sunfish
- Warmouth x Bluegill
- Green sunfish x Bluegill
- Green sunfish x Pumpkinseed
- Green sunfish x Longear sunfish
- Green sunfish x Redbreast sunfish
- Green sunfish x Red-ear sunfish
- Green sunfish x Orangespotted sunfish
- Bluegill x Red-ear sunfish
- Bluegill x Pumpkinseed
- Bluegill x Orangespotted sunfish
- Bluegill x Longear sunfish
- Bluegill x Redbreast sunfish
- Pumpkinseed x Orangespotted sunfish
- Pumpkinseed x Redbreast sunfish
- Pumpkinseed x Longear sunfish
- Longear sunfish x Orangespotted sunfish
- Warmouth x Red-ear sunfish
- Bluegill x Spotted sunfish

Reference

- Radcliffe (1914:27)²
- McAtee & Weed (1915:13)¹
- McAtee & Weed (1915:13)¹
- Hubbs (1920:102)²
- Bailey & Lagler (1938:588-604)²
- Bailey & Lagler (1938:588-604)²
- Cross & Moore (1952:410-411)²
- Raney (1940:364)¹
- Trautman (1957:501)¹
- Hubbs & Ortenburger (1929:42)¹
- Cross & Moore (1952:411)²
- Bailey & Lagler (1938:588-604)²
- Cross & Moore (1952:411)²
- Cross & Moore (1952:411)²
- Bailey & Lagler (1938:577)¹
- O'Donnell (1953:487)¹
- Greeley & Bishop (1933:101)¹
- Hubbs (1926:72)¹
- O'Donnell (1935:487)¹
- Childers (unpublished)
- Stinauer & Childers (unpublished)

¹Contains no description.
²Contains description.

coast species were probably restricted to a southern coastal distribution and are represented today by one relic species, the Sacramento perch.

- 8) During the Pleistocene northern species east of the Rocky Mountains withdrew in a southeasterly direction or became extinct.
- 9) Speciation in the genus *Lepomis* probably has proceeded at a rapid rate during the Recent epoch.

Reported Natural Lepomini Hybrids

It is theoretically possible for the 11 species of Lepomini to hybridize in 110 different F_1 combinations; however, since it appears impossible morphologically to differentiate between hybrids of reciprocal crosses (Hubbs & Hubbs 1932:433), only 55 morphologically different Lepomini F_1 hybrids could be identified. Of this number at least 21 have been found in nature. In the list of naturally occurring Lepomini hybrids (page 161), an attempt has been made to give credit to the author of the first published description of each kind.

SPECIES SELECTED FOR STUDY

Four species of sunfishes in the tribe Lepomini (red-ear sunfish, bluegill, green sunfish, and warmouth) were selected as experimental species because of local availability; importance to sport fishing; taxonomic relationships; and similarities and differences in their morphology, habitat selection, and reproductive behavior.

Geographic Distribution

The natural geographic ranges of the four species greatly overlap one another (Trautman 1957: 497, 500, 504, 517). All four species are sympatric in east-central Illinois, and they are quite abundant in a number of lakes and ponds in this area. Bluegills, green sunfish, and warmouths are indigenous to east-central Illinois, and the red-ear

sunfish, a more southern species, was successfully introduced into this area in 1946 (Bennett 1958:177).

Diagnostic Morphological Characters

Forbes & Richardson (1920:245-251, 257-259) and Trautman (1957:496-504, 516-518) give good morphological descriptions of the four experimental species. Certain key morphological characteristics of the four species are presented in Table 1.

Habitat Selection

Larimore (1957:2), in discussing the distribution of the warmouth in Illinois, stated that although the warmouth is principally a pond and lake fish, it occurs in the Rock, Mississippi, and Illinois rivers and is reported as common in small, sluggish streams in the southern part of the state. In east-central Illinois warmouth are only occasionally found in streams. Many of the creeks and some larger streams in this area have been dredged and are unsuitable for most species of fishes. The undredged portions of these streams are probably unsuitable for warmouths because their current velocities are greater than warmouths can tolerate. Trautman (1957:498) reports that in Ohio

The Warmouth Sunfish was most numerous in lakes, ponds, oxbows, marshes, and streams of base or very low gradients which had silt-free water, an abundance of aquatic vegetation, and a mucky bottom which was often covered with organic debris. The species was present only in small numbers in weedless oxbows and ponds which had a yellow-silt bottom, and although its colloquial name was "Mud Bass" it seemed to be less tolerant to turbidity and siltation than was the Green Sunfish.

The green sunfish is abundant in creeks and small rivers in east-central Illinois (Forbes & Richardson 1920:250; Larimore & Smith 1963:325). This species is adept at ascending small temporary streams formed by overflow waters from lakes and ponds. Green sunfish are prolific and frequently gain access to a new lake or pond before other species of sunfishes. When this

occurs, they commonly produce such large populations that the individuals become stunted. Green sunfish are usually unable to compete successfully with other species of sunfishes which typically inhabit clear-water lakes and ponds. Trautman (1957:501) stated that the green sunfish is more tolerant of turbidity and siltation than other sunfishes except the orangespotted; however, the largest populations were found in clear-water habitats under conditions of low competition with other sunfish species.

In east-central Illinois the largest populations of bluegills and red-ear sunfish occur in lakes and ponds which have relatively clear waters. Forbes & Richardson (1920:258) found that the bluegill occurred throughout Illinois, but it was generally limited to the larger streams and their principal tributaries and was common in north-eastern glacial lakes. During the past 30 years bluegills have been stocked in thousands of Illinois lakes and farm ponds by federal and state agencies (Bennett 1962:104).

In 1951 the Illinois Department of Conservation obtained red-ear sunfish breeding stock from Dr. G. W. Bennett of the Illinois Natural History Survey. These adult fish were offspring of the red-ear sunfish which were introduced into east-central Illinois from Indiana in 1946 (Lopinot 1961:3). From 1951 to 1964 the Illinois Department of Conservation stocked 1,383 lakes and ponds with red-ear sunfish, and this species has been widely distributed throughout the state (W. J. Harth, personal communication).

Trautman (1957:518) remarked that wherever the red-ear sunfish has been introduced into waters which are north of its natural range, it has essentially inhabited nonflowing waters which were relatively clear and contained at least some aquatic vegetation. Trautman also stated that at Buckeye Lake, Ohio, the red-ear sunfish seemed to re-

quire as much as, or more aquatic vegetation than, did the bluegill, and that although both species frequented open water, the red-ear congregated about brush, stumps, and logs more than the bluegill.

Reproduction

The reproductive activities of the four kinds of sunfishes were observed over a 7-year period, from 1958 through 1964, in a number of lakes and ponds within 50 miles of Urbana, Ill. The most frequent observations were made in Big Pond (owned by William Utterback and located 5 miles south-east of Gibson City, Ill.) and Lake Italy (owned by the Material Service Corporation and located 3 miles south of Fairmount, Ill.) Big Pond contained bluegill, red-ear, and green sunfishes, and Lake Italy contained all four species.

TIME OF SPAWNING.—For all four species, males in spawning condition were first collected each year during late April or early May. The first ripe females were collected during the 2nd or 3rd week of May. The first fish to become ripe were invariably large individuals. Ripe individuals from stunted populations of bluegills and green sunfish were first collected 2–4 weeks later than from nonstunted populations. Ripe males and females of all four species were collected each month, May through August; however, ripe individuals were much less abundant during July and August than during May and June. The latest observed fall spawning occurred in Big Pond during the 1st week of September, 1960.

Big Pond is naturally divided into three areas which are connected by two short, narrow, shallow channels. On August 24, 1960, the three areas were separated by placing heavy canvas barriers across both channels. Two areas were treated with rotenone. On September 5 both treated areas were inspected to determine if any fish had

Table 1.—Certain key morphological characters of typical adult red-ear sunfish, bluegills, green sunfish, and warmouths (modified slightly from Forbes & Richardson 1920; Trautman 1957).

Morphological Character	Red-ear Sunfish	Bluegill	Green Sunfish	Warmouth
Teeth on tongue	None	None	Rarely a few	Well developed
Supramaxilla	Rudimentary or lacking	Rudimentary or lacking	Small or rudimentary	Well developed
Orange-red spot at bases of last 3 dorsal rays	Absent	Absent	Absent	Well developed in males, less so in females
Mouth size	Moderately small	Very small	Large	Large
Posterior edge of upper jaw extends	Almost to or to anterior edge of eye	Rarely to anterior edge of eye	To center of eye or beyond	To center of eye or beyond
Length of pectoral fin	Very long	Long	Short	Moderately short
Tip of pectoral fin, when laid forward across the cheek, reaches	Almost to or to tip of snout	Beyond anterior edge of eye	Posterior edge of eye	Posterior edge of eye
Tip of pectoral fin	Very pointed	Pointed	Round	Moderately round
Length of longest dorsal spine	Long	Long	Short	Moderately short
Length of longest dorsal spine/head length*	About $\frac{1}{2}$	About $\frac{1}{2}$	Usually $\frac{1}{4}$	About $\frac{1}{4}$

Gill rakers on first gill arch	Short, blunt, and often crooked	Moderately long, straight, and thin	Long, straight, and thin	Long and straight
Longest gill raker	About 1/3 diameter of eye	Almost 1/3 diameter of eye	Fully 1/2 diameter of eye	Fully 1/2 diameter of eye
Teeth on lower pharyngeal arches	Molar-like, bluntly pointed or rounded	Conical, thin, and sharply pointed	Conical, blunt with heavy basal portion	Conical, blunt with heavy basal portion
Lower pharyngeal arches	Broad and strong	Narrow and strong	Narrow and strong	Narrow and strong
Bony portion of opercle flap	Moderately flexible	Very flexible	Inflexible	Inflexible
Color of opercle membrane	White or slate gray with red spot on posterior edge	Black	Coppery to purplish	Coppery above to lavender below
Markings on side of head	Reddish-brown, irregular spots	2 broad, bluish bands, ventrally located	3-5 narrow, wavy, broken emerald lines	3-5 dark bands
Dusky spot in soft dorsal fin	None	Above bases of last 3 rays, sometimes absent	At bases of last 3 rays, sometimes absent	None
Dusky spot in soft anal fin	None	If present, usually poorly developed	At bases of last 3 rays, sometimes absent	None
Color of ventral fins	Dusky yellow	Dusky	Yellow	Transparent to light olive
Soft-rayed dorsal fin edged with	Nothing	Faint iridescent blue	Whitish to yellowish orange	Red in breeding males, white to absent in others

^oHead length: the distance from the tip of the snout to the posterior margin of the bony portion of the opercle flap.

survived the rotenone treatment. The fish kill appeared to be complete in one area, but in the other approximately 30 male bluegills were occupying nests. All nests contained either eggs or larval young. A careful inspection of the untreated area failed to reveal a single nesting sunfish.

Swingle (1956:865) suggested that certain species of fishes secrete or excrete a hormone-like substance which acts as a repressive factor and inhibits reproduction in ponds containing dense fish populations. Apparently the rotenone treatment with its resulting drastic reduction of the fish population stimulated the few surviving bluegills to reproduce within about 9–11 days during a period which was somewhat later than their normal spawning season in east-central Illinois.

In Alabama, red-ear sunfish spawned in the spring when surface water reached a temperature of about 24° C. (75° F.), reproduced sparingly or not at all during the summer, and again spawned heavily in the early fall (Swingle 1949:299). I have observed no extensive fall spawning of red-ear sunfish in any east-central Illinois lakes and ponds.

In Fork Lake, Ill., during 1939, the bluegills of both sexes had gonads in spawning condition during June, July, and August. Males matured earlier than females and large males became sexually mature earlier than smaller males. Nests were first observed on May 28 when the water temperature at 3 feet was 25° C. (77° F.). Occupied nests were last observed on September 18 (Bennett, Thompson, & Parr 1940:17–18).

In the Gardner Ponds at the University of Wisconsin Arboretum the spawning season of green sunfish commenced in late May or early June when the water temperature reached about 21° C. (70° F.), continued through June and July, and terminated in early August. Apparently larger males

spawned earlier and more frequently than smaller males (Hunter 1963:16–18).

In Park Pond, Vermilion County, Ill., warmouth spawning was initiated during the 2nd week in May, 1949, when the water temperature at 12 inches was approximately 21° C. (70° F.). Gonadal weight-body weight ratios indicated that most spawning was completed by early July. Warmouths of less than 89 mm (3.5 inches) total length failed to spawn. Males ripened earlier in the season than females and large fish spawned earlier than smaller ones (Larimore 1957:31–35).

LOCATION OF NESTS.—The first evidence of reproductive activity in the spring was the movement of males into shallow water. As the length of the photoperiod and the temperature of the water increased, males constructed nests (saucer-shaped depressions in the substrate) which they defended with great vigor.

All four species usually nested in areas where the water was less than 3 feet deep. Red-ear sunfish, bluegills, and green sunfish normally nested in colonies, on firm substrates, and often in locations exposed to the sun. Warmouths were more solitary in their nest site selections. They frequently nested on soft substrates even when firm substrates were available. Larimore (1957:40) reported that warmouths were not as consistent in selecting a particular type of substrate as they were in selecting a spot near a stump, rock, root, clump of vegetation, or some similar object, and that nests were never found on an area of bottom completely exposed, such as was usually chosen by the bluegill.

In Utterback's Big Pond and Lake Italy, red-ear sunfish males and bluegill males were frequently found nesting together in the same colony. Green sunfish males were less commonly found nesting with males of the other species; however, this difference may

have been related to the smaller numbers of green sunfish in both bodies of water. Warmouth males were never observed nesting in colonies. In colonies of nests occupied by more than one species, males of the minority species formed a subcolony within the larger group.

SPAWNING AND CARE OF YOUNG.—

In general the four species are remarkably similar in their spawning and parental behavior. During spawning a pair slowly swims side by side in tight circles over the male's nest. Fertilization is external and the demersal eggs adhere to the material forming the bottom of the nest. After spawning, the female leaves or is driven from the nest by the male, and the male fans the eggs and larval young until they become free-swimming fry. During fanning, the male hovers over the nest while undulating his body in such a way that currents of water are directed downward into the nest. Fanning can best be described as stationary swimming. The water currents thus produced are probably important in cleansing and oxygenating the developing embryos. During this period, the male also protects the eggs and young and will viciously attack predators much larger than himself.

DURATION OF FERTILITY OF GAMETES.

—Since three of the four species selected for study sometimes nest in mixed colonies, the functional life spans of gametes could be very important in controlling hybridization between these species. If gametes are capable of fertilizing and being fertilized over long periods of time, sperm driftage could result in the production of hybrid individuals. Experiments were conducted to determine the functional life spans of bluegill, green sunfish, and warmouth gametes. In one set of experiments, both sperm and eggs were aged for various periods of time prior to fertilization; in another group of experiments only eggs were aged.

Ripe male and female bluegills, green sunfish, and warmouths were captured by seining and trapping in local ponds.¹ These fish were moved into the laboratory and separated in aquaria according to species and sex. Fish were held in these aquaria for one-half hour to 2 hours before gametes were stripped from them. Care was taken to avoid any temperature shock to the fish prior to their use in the experiments.

In the experiments in which both sperm and eggs were aged prior to fertilization, the method was: Five clean glass petri dishes were individually numbered from 1 to 5. Each dish was then partially filled by adding 20 ml of water. All of the water used in these experiments was obtained from the well on Parkhill's Lake Park Subdivision Number Two. The water was moved into the Illinois Natural History Survey laboratory and stored in a 210-gallon aquarium. It was aerated and filtered through activated charcoal for at least 1 week prior to its use. A partial chemical analysis of this water is presented in Table A1 in the appendix.

Starting with dish 1 and ending with dish 5, eggs from a ripe female warmouth were stripped into each of the five dishes. Immediately after eggs were stripped into a dish, the dish was gently shaken to scatter the eggs over the bottom. Eggs were stripped into consecutive dishes at approximately 7-second intervals, and so the entire egg-stripping process was completed in about 30 seconds. During the next 15 seconds, one-half ml of seminal fluid was stripped from a ripe male warmouth and diluted with 10 ml of water. One ml of this solution was then added to the water and eggs in dish 1, and to the

¹All sunfishes used in these experiments were obtained from these Illinois ponds: bluegills and green sunfish from Pifers Pond, about 3 miles southeast of Sullivan, and Utterback's Big Pond, 5 miles southeast of Gibson City; bluegills from Redhead's Pond, 4 miles east of Homer; warmouths and green sunfish from Lake of the Woods, 2 miles northeast of Mahomet; warmouths from Taylor's Pond, 3 miles southwest of Fairmount.

other dishes in sequence after intervals of 2.5, 5.0, 7.5, and 10.0 minutes. From 5 to 10 minutes after the gametes were mixed in each dish, the zygotes were washed three times (by decanting and refilling each dish with clean water) and then enough water was added to each dish to cover the eggs.

Water in each dish was changed several times during incubation, and dead eggs and embryos were removed. Newly hatched larvae were transferred to clean, numbered dishes. The number of eggs in each dish at time of fertilization, the number of eggs which hatched, and the number of larvae which developed into normal-appearing swim-up fry were recorded. The incubation temperature was recorded with an air thermograph located directly alongside the petri dishes.

The same procedure was followed in measuring the functional life spans of bluegill and green sunfish sperm and eggs, except that six egg samples were stripped from each female and the time interval separating the mixing of gametes in the sequence of dishes was 1.0 minute instead of 2.5 minutes.

In the second group of experiments

only the eggs of the three species were aged prior to fertilization. The procedure of the first group of experiments was used, except that two drops of undiluted seminal fluid were stripped directly on the eggs after they had been aged for 0.5, 30.0, 60.0, 120.0, and 180.0 minutes.

The results of individual experiments concerning the functional life spans of activated gametes of bluegills, green sunfish, and warmouths are presented in Tables A2-A13 of the appendix. Data from experiments for each species were pooled and are presented in Tables 2-4.

Under the conditions of these experiments "average functional lives" (length of time gametes were aged that resulted in a 50-percent reduction in fry viability) of warmouth, bluegill, and green sunfish eggs were interpolated to be 94, 60, and 47 minutes, respectively. Specific differences may have been the result of variation in the physiological state of the mature eggs and the exposure of the various samples to uncontrollable environmental differences.

All of the eggs in an individual exper-

Table 2.—Duration of fertility of activated warmouth gametes. Data from experiments W1-W4 are combined.

Age of Eggs in Minutes	Age of Sperm in Minutes	Number of Eggs	Percent of Eggs that Hatched	Percent of Eggs that Developed into Fry ^a
Aging of Sperm and Eggs				
0.75	0.25	118	46	44
3.15	2.75	231	10	9
5.55	5.25	150	0	0
8.45	7.75	178	0	0
10.35	10.25	123	0	0
Aging of Eggs				
0.50	0	128	92	80
30.00	0	161	53	52
60.00	0	172	59	56
120.00	0	150	33	29
180.00	0	178	3	1

^aFry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table 3.—Duration of fertility of activated bluegill gametes. Data from experiments B1–B4 are combined.

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry*</i>
Aging of Sperm and Eggs				
1.00	0.25	92	65	48
1.90	1.25	74	49	24
2.80	2.25	76	12	12
3.70	3.25	85	1	1
4.60	4.25	65	0	0
5.50	5.25	64	0	0
Aging of Eggs				
0.50	0	210	81	80
30.00	0	143	69	67
60.00	0	123	42	40
120.00	0	196	19	16
180.00	0	124	9	7

*Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table 4.—Duration of fertility of activated green sunfish gametes. Data from experiments G1–G4 are combined.

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry*</i>
Aging of Sperm and Eggs				
1.00–2.25	0.25	163	48	44
1.90–3.15	1.25	141	18	18
2.80–4.05	2.25	105	3	3
3.70–4.95	3.25	223	3	2
4.60–5.85	4.25	139	1	1
5.50–6.75	5.25	158	2	2
Aging of Eggs				
0.50	0	141	58	57
30.00	0	222	39	37
60.00	0	216	23	21
120.00	0	152	20	18
180.00	0	171	13	12

*Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

iment were from a single female; however, eggs from one female may vary in their physiological response to fertilization. The first eggs to flow often appeared to be more nearly ripe than those which followed. Consequently if eggs from a female were slightly green, serial samples of her eggs would exhibit

a decrease in the percentage hatching, but if her eggs were slightly past optimum ripeness, serial samples might increase in hatchability. Even though dead zygotes were removed and the water in the dishes was changed at frequent intervals during each experiment, carbon dioxide and dissolved

oxygen tensions were probably variable and more critical in dishes where mortality was high. Chance contamination of some samples by bacteria and protozoans also may have resulted in environmental differences in various samples.

The average functional life spans of sperm (based on the age of the sperm in the experiments in which both eggs and sperm were aged) from warmouths, green sunfish, and bluegills were interpolated to be 1.1, 1.0, and 1.0 minutes, respectively. Specific differences in the results of these experiments were probably not valid because of the factors previously described.

The average functional life span of eggs from the three species was 67 minutes, and for sperm it was 1 minute. Functional life spans of gametes from red-ear sunfish were not investigated; however, they are probably similar to those of warmouths, bluegills, and green sunfish.

The brief functional life spans of the spermatozoans of these species are undoubtedly very important in reducing hybridization caused by sperm drifting from nest to nest.

HYBRIDIZATION EXPERIMENTS

Two types of experiments were used to produce hybrid sunfishes. In the first, referred to as "stripping experiments," gametes were stripped from ripe adults and manually mixed. With this method it was possible to determine species isolation due to incompatibilities between sperm and eggs (primary genetic isolation). In the second type, designated "isolation experiments," one or more pairs of fish composed of a male of one species and a female of another were isolated in small ponds to determine if they would hybridize when mates of their own species were absent.

In this paper R refers to red-ear sunfish, B to bluegill, G to green sunfish, and W to warmouth. Matings between individuals of different species are designated as P_1 crosses, and the resultant

hybrids are designated as F_1 hybrids. F_2 hybrids are those produced by mating an F_1 male with an F_1 female. The male parent species is always given first; thus, the P_1 cross of a male bluegill and a female green sunfish is designated B x G and the resultant hybrids are designated BG F_1 hybrids; GB F_1 designates the reciprocal hybrids.

Stripping Experiments

Sperm and eggs stripped from the four parent species were paired in 16 different combinations to produce zygotes representing the four parent species and 12 hybrids. These experiments were designed to allow comparisons of rates of embryological development and the extent of viability of F_1 hybrids and their maternal parent species.

METHODS AND MATERIALS.—Ripe males and females of the four species were brought into the laboratory from nine local ponds. Laboratory treatment of these fish was the same as for those used in experiments concerned with functional life spans of gametes.

A ripe female of one of the four species and one ripe male of each of the four species were used in each experiment. No individual fish was used more than once. Fish selected for an experiment were individually isolated for at least 30 minutes before gametes were stripped, and the person doing the stripping rinsed and dried his hands after handling each fish.

Twelve clean petri dishes were individually marked and 20 ml of aged, filtered well water were added to each dish. A sample of eggs from one ripe female was stripped into each of the 12 petri dishes, and the eggs were scattered by gently shaking the dishes. Two drops of milt were then stripped into each dish. Milt from one male of each of the four species was used to fertilize the eggs in three dishes. An entire stripping program for the five fish was completed in less than 5 minutes. Approximately 10 minutes after the stripping was completed, the zygotes were

washed three times by decanting and refilling each dish with clean water. During incubation the amount of water in each dish was regulated so that the developing embryos were always covered with a thin layer (2–8 mm) of water.

Dead embryos were removed, and the water covering the living embryos was changed several times during each experiment. The frequency with which dead embryos were removed and water was changed was varied according to the incubation temperature. In the experiments with the highest (28.6° C.) and the lowest (22.3° C.) mean incubation temperatures the intervals were approximately 5 and 24 hours, respectively. Larvae were transferred to clean, numbered dishes within 1 hour after hatching.

An air thermograph was used to record temperatures adjacent to the dishes containing the embryos. The maximum range of fluctuation of air temperature during any one experiment was 3° C. Hourly air temperature fluctuations never exceeded 0.7° C. Since the petri dishes contained relatively small amounts of water and since air temperature fluctuations were slight, water temperatures were considered to be the same as air temperatures in these experiments. Records were made of the number of eggs in each dish at the time sperm and eggs were mixed, the number of eggs that hatched each hour, and the number of larvae that developed into morphologically normal-appearing swim-up fry. Upon termination of each experiment, all living fry were killed with a 4-percent aqueous solution of formaldehyde and stored in a 1-percent solution. Total body lengths of 25 morphologically normal-appearing fry of each kind of viable fry from each experiment were measured to the nearest 0.03 mm with an ocular micrometer.

A total of 11 stripping experiments was conducted: Eggs from three red-ear sunfish, three bluegills, three green

sunfish, and two warmouths were fertilized with sperm from males of all four species. The temperatures at which these experiments were conducted were well within the range of temperatures that embryos of the four species are subjected to under natural conditions. Nine of the experiments were terminated when the zygotes developed into swim-up fry. The other two experiments, both of which were conducted with red-ear sunfish eggs, were terminated shortly after the fry became free swimming.

RESULTS AND DISCUSSION.—The percentages of eggs that hatched and the percentages of eggs that developed into morphologically normal-appearing fry were calculated for each of the 132 samples of the 11 experiments (Tables A14–A24 of the appendix). These percentages were transformed into degrees of a right angle to minimize bias inherent in using weighted percentages in an analysis of variance (Fisher & Yates 1963:74–75). A 7094 digital computer was used in analyzing these data. Data from the 11 stripping experiments were condensed and are presented in Tables 5–8.

Preliminary tests revealed that high percentages of eggs hatched in some petri dishes containing as many as 500 eggs; however, mortality was higher in dishes containing 400–500 eggs than in dishes containing 200–300 eggs. Since the number of eggs per sample was a variable in these experiments, the number was purposely kept low (mean number of eggs per sample was 65) to minimize the effect of crowding. An analysis of variance revealed that there was no significant correlation between the number of eggs per sample and the percentage that hatched. Consequently, the number of eggs per sample was used as a statistical weight in the analysis of the viabilities of the 16 different kinds of zygotes.

Data from the 11 stripping experiments pertaining to the percentages of eggs that hatched and the percentages

Table 5.—Some aspects of the embryonic development of red-ear sunfish and BR, GR, and WB F₁ hybrid sunfishes.

Parents	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry	Length of Fry in mm		
			Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Mean	Standard Deviation
Experiment S1, 161 hours, average temperature 23.6° C., standard deviation 0.77° C.										
R x R	135	45	50.3	5.36	23.8	0.41	38	25	4.78	0.300
B x R	147	58	52.1	4.45	23.8	0.40	50	25	4.86	0.139
G x R	117	57	49.6	5.33	23.8	0.41	50	25	4.98	0.165
W x R	123	36§	49.1	4.38	23.8	0.41	0	0	...	...
Experiment S2, 120 hours, average temperature 28.7° C., standard deviation 0.44° C.										
R x R	234	33	26.6	1.94	28.5	0.29	23	25	4.99	0.155
B x R	214	30	28.4	1.80	28.6	0.31	25	25	5.13	0.192
G x R	231	38	27.7	2.31	28.6	0.31	27	25	5.10	0.189
W x R	184	35§	27.9	2.65	28.6	0.31	5**	0	...	...
Experiment S3, 120 hours, average temperature 28.7° C., standard deviation 0.44° C.										
R x R	143	44	28.1	2.18	28.6	0.31	24	25	5.28	0.166
B x R	151	41	28.2	1.79	28.6	0.31	29	25	5.58	0.137
G x R	204	49	28.2	1.94	28.6	0.31	41	25	5.54	0.185
W x R	241	27§	26.5	2.67	28.5	0.27	2**	0	...	...

*R = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

†Percentage based on eggs in each sample at the time sperm and eggs were mixed.

‡Incubation temperature from time of fertilization to mean time of hatching.

§More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.

**Appeared morphologically normal, but all were behaviorally abnormal.

Table 6.—Some aspects of the embryonic development of bluegill and RB,* GB, and WB F₁ hybrid sunfishes.

Parents	Number of Eggs	Percent† Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.‡		Percent† Normal Fry	Length of Fry in mm		
			Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Mean	Standard Deviation
Experiment S4, 184 hours, average temperature 22.6° C., standard deviation 0.68° C.										
♂ x ♀										
B x B	261	87	71.1	3.32	22.3	0.24	56	25	4.28	0.172
R x B	363	81	67.9	2.80	22.3	0.24	76	25	4.42	0.108
G x B	271	82	73.4	4.78	22.3	0.23	41	25	4.48	0.144
W x B	302	22§	59.8	4.04	22.3	0.23	0	0	...	...
Experiment S5, 113 hours, average temperature 26.9° C., standard deviation 0.48° C.										
B x B	257	84	33.9	2.06	26.8	0.37	83	25	4.98	0.110
R x B	195	94	34.6	1.66	26.8	0.37	93	25	4.98	0.151
G x B	219	92	34.3	2.14	26.8	0.37	88	25	5.00	0.164
W x B	214	90§	29.4	1.49	26.8	0.40	0	0	...	...
Experiment S6, 105 hours, average temperature 27.3° C., standard deviation 0.65° C.										
B x B	163	90	32.5	0.83	27.0	0.42	90	25	4.69	0.076
R x B	184	88	31.8	0.83	27.0	0.40	85	25	4.63	0.069
G x B	149	91	32.3	1.01	27.0	0.40	91	25	4.61	0.095
W x B	183	93§	27.9	1.77	26.8	0.28	3**	0	...	...

*R = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.
†Percentage based on eggs in each sample at the time sperm and eggs were mixed.
‡Incubation temperature from time of fertilization to mean time of hatching.
§More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.
**Appeared morphologically normal, but all were behaviorally abnormal.

Table 7.—Some aspects of the embryonic development of green sunfish and RG,^{*} BG, and WG F₁ hybrid sunfishes.

Parents	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C. [†]		Percent Normal Fry	Length of Fry in mm	
			Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Mean
♂ x ♀									
Experiment S7, 151 hours, average temperature 24.4° C., standard deviation 0.46° C.									
G x G	156	76	50.0	2.37	23.8	0.27	74	25	4.79
R x G	134	86	48.0	1.64	23.8	0.26	86	25	4.62
B x G	182	74	49.5	2.52	23.8	0.27	71	25	4.74
W x G	152	84	48.7	2.64	23.8	0.27	61	25	4.60
Experiment S8, 104 hours, average temperature 27.3° C., standard deviation 0.66° C.									
G x G	306	76	31.5	2.08	27.1	0.44	74	25	4.72
R x G	206	81	31.7	0.95	27.1	0.44	79	25	4.84
B x G	192	74	31.4	1.20	27.0	0.42	74	25	4.85
W x G	214	81	29.8	1.96	27.0	0.41	50	25	4.68
Experiment S9, 78 hours, average temperature 28.1° C., standard deviation 0.51° C.									
G x G	177	82	29.1	1.75	27.6	0.32	78	25	4.64
R x G	257	77	27.4	1.45	27.6	0.31	77	25	4.53
B x G	215	72	28.0	1.57	27.6	0.31	66	25	4.69
W x G	312	68	29.0	1.46	27.6	0.32	57	25	4.53

^{*}R = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.[‡]Incubation temperature from time of fertilization to mean time of hatching.

Table 8.—Some aspects of the embryonic development of warmouth and RW,^a BW, and GW F₁ hybrid sunfishes.

Parents	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry	Length of Fry in mm		
			Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Mean	Standard Deviation
Experiment S10, 115 hours, average temperature 27.2° C., standard deviation 0.45° C.										
W x W	179	51	29.4	1.55	27.3	0.33	45	25	4.75	0.176
R x W	175	47	29.4	1.31	27.3	0.33	43	25	4.63	0.139
B x W	197	53	30.8	1.29	27.3	0.33	45	25	4.74	0.180
G x W	146	55	30.9	1.37	27.3	0.33	35	25	4.76	0.212
Experiment S11, 78 hours, average temperature 28.1° C., standard deviation 0.51° C.										
W x W	116	69	28.9	1.56	27.6	0.31	56	25	4.72	0.204
R x W	142	80	29.2	1.03	27.6	0.31	68	25	4.60	0.199
B x W	114	68	28.9	1.24	27.6	0.31	54	25	4.77	0.141
G x W	130	71	29.7	1.00	27.6	0.32	62	25	4.90	0.203

^a R = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.[†] Percentage based on eggs in each sample at the time sperm and eggs were mixed.[‡] Incubation temperature from time of fertilization to mean time of hatching.

of eggs that developed into morphologically normal-appearing fry were combined and are presented in Table 9. The percentages of hatched zygotes of the four pure species were compared with one another. Statistically, the hatching success of red-ear sunfish zygotes (39 percent) was significantly less (0.01 level) than that of warmouth (58 percent), green sunfish (78 percent), and bluegill zygotes (87 percent). The warmouth hatching percentage was significantly less than those of the green sunfish (0.05 level) and the bluegill (0.01 level). The hatching success of green sunfish zygotes was not significantly different from that of bluegill zygotes. These differences are not believed to represent valid differences between the hatchabilities of eggs of the four species, but are probably the result of differences in the maturity of eggs from the females used in these experiments. Consequently, to minimize such differences, the percentage of eggs

that hatched and the percentage of normal-appearing fry of each hybrid type were compared with those of its maternal parent species.

No hybrid type was significantly different from its maternal parent species in the percentage of zygotes that hatched; however, more than 90 percent of the WR and WB F₁ hybrids were morphologically abnormal (Fig. 1 and 2).

Both WR and WB F₁ hybrids exhibited high mortality between the hatching and swim-up fry stages. At the time the experiments were terminated, only 2 percent of the WR hybrids and 1 percent of the WB hybrids appeared to be morphologically normal. All of these morphologically normal-appearing WR and WB F₁ hybrid fry were very sluggish. When petri dishes containing these hybrid fry were tapped with a pencil, the fry responded with weak swimming movements or not at all, and it is very doubtful that

Table 9.—The degree of viability of 16 different kinds of fishes produced by pairing gametes from red-ear sunfish, bluegills, green sunfish, and warmouths. Data from experiments S1-S11 are combined.

Parent Species ^o	Number of Eggs	Percent [†] Hatched	Percent [‡] Normal Fry
♂ x ♀			
R x R	512	39	27
B x R	512	41	33
G x R	552	46	37
W x R	548	32§	2**
B x B	681	87	75
R x B	742	86	83
G x B	639	87	69
W x B	699	61§	1**
G x G	639	78	75
R x G	597	80	79
B x G	589	73	70
W x G	678	76	55
W x W	295	58	49
R x W	317	62	58
B x W	311	58	44
G x W	276	62	47

^oR = red-ear sunfish, B = bluegill, G = green sunfish, W = warmouth.

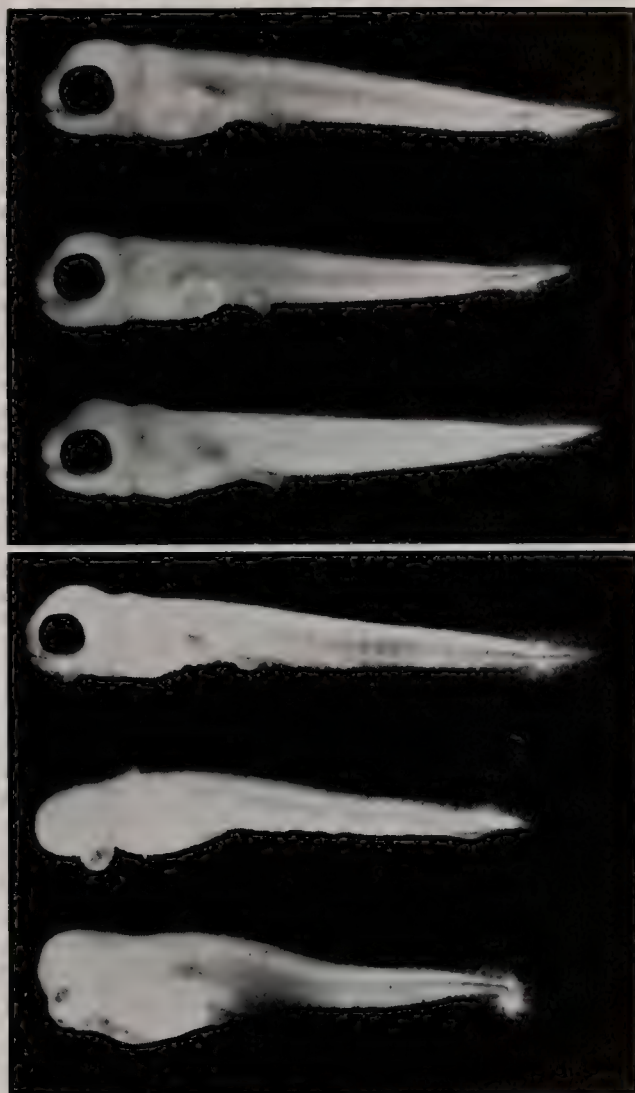
[†]Percentage based on number of eggs at the time sperm and eggs were mixed together and the number that hatched.

[‡]Percentage based on number of eggs at the time sperm and eggs were mixed together and the number of morphologically normal-appearing fry.

[§]More than 90 percent of these larvae were morphologically deformed.

**These fry appeared morphologically normal, but all were behaviorally abnormal.

Fig. 1.—Red-ear sunfish fry (above) and WR F_1 hybrid fry (below) selected to show the range of morphological deformities of the hybrid fry. All fry were produced from eggs from one female red-ear sunfish. Both kinds of zygotes were allowed to develop simultaneously under similar conditions for 120 hours before being sacrificed. The mean hourly temperature was 28.7° C. (83.6° F.), standard deviation, 0.44° C. (0.79° F.).



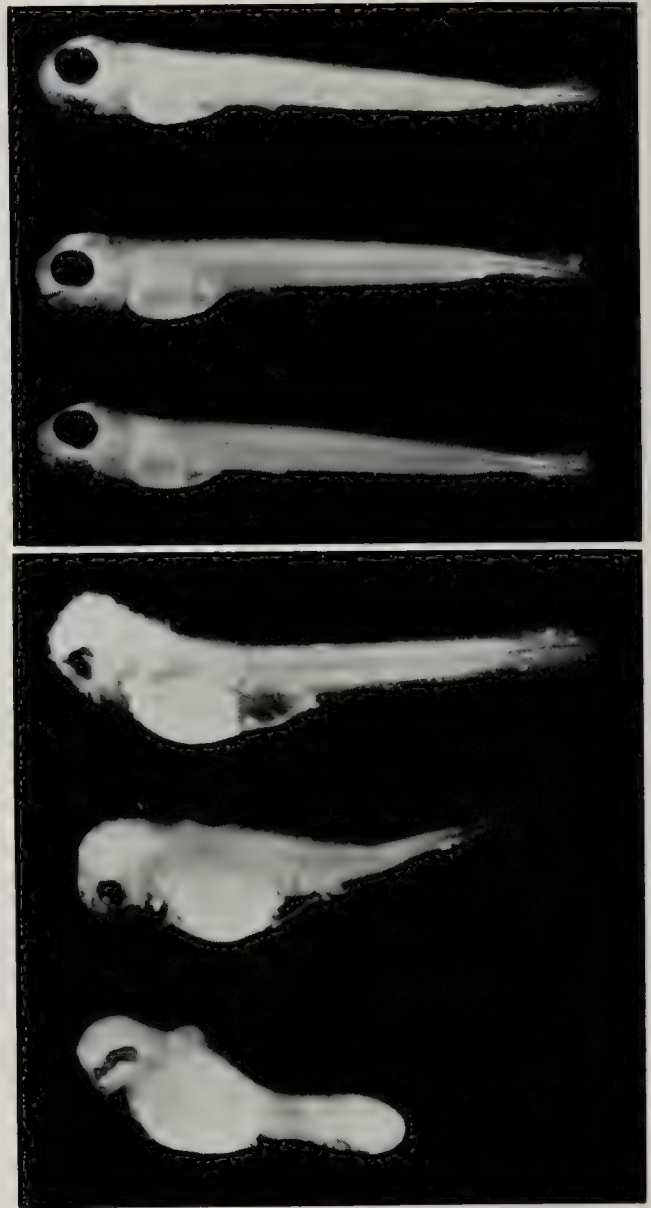
any of these fry would have become free swimming. Fifty-five percent of the WG hybrid and 75 percent of the pure green sunfish zygotes developed into normal-appearing swim-up fry (difference significant to 0.05 level). The WG hybrid swim-up fry appeared to be behaviorally normal. The remaining nine kinds of hybrids were not significantly different from their maternal parent species in the percentages that developed into normal swim-up fry.

The mean hatching time and stand-

ard deviation were calculated for each of the 132 samples of eggs in the 11 experiments (Tables A14-A24 of the appendix). A statistical weight was calculated for the mean hatching time of each sample by dividing the number of eggs that hatched by the variance of the mean hatching time. A 7094 digital computer was used in the analysis of variance of these data.

The statistical analysis, in which the weighted mean hatching time of each kind of hybrid was compared with that

Fig. 2. — Bluegill fry (above) and WB F_1 hybrid fry (below) selected to show the range of morphological deformities of the hybrid fry. All fry were produced from eggs from one female bluegill. Both kinds of zygotes were allowed to develop simultaneously under similar conditions for 113 hours before being sacrificed. The mean hourly temperature was 26.9°C . (80.4°F .), standard deviation, 0.48°C . (0.86°F .).



of its maternal parent species, revealed that WB F_1 hybrid zygotes hatched significantly sooner than pure bluegill zygotes when both kinds of zygotes were incubated at the same temperatures. Although WB zygotes hatched in less time, the newly emerged WB F_1 larvae were not as advanced in their development as the unhatched pure

bluegill embryos. WR F_1 hybrids were not significantly different from pure red-ears in hatching time; however, the newly emerged WR larvae were not as advanced in their development as the pure red-ear larvae. There were no statistically significant differences in the time of hatching between the other 10 kinds of hybrids and their respective

maternal parent species, and differences in the degree of development between the hybrids and their respective maternal parent species were not pronounced.

The mean body length and standard deviation were calculated for each kind of viable fry from each experiment (Tables 5-8). An analysis of variance in which the mean body length of each kind of viable hybrid fry was compared to that of its maternal parent species revealed that BR and GR were significantly (0.05 level of probability) longer bodied than the pure red-ear fry. The other eight kinds of hybrids were not significantly different from their respective maternal parent species fry in total body length.

The alpha temperature threshold of development (Shelford 1927:357) and the mean number of developmental units (degree-hours of effective temperature) necessary for 50-percent hatching were calculated for each of the 16 kinds of zygotes. The statistical method was designed by Dr. H. W. Norton¹ to determine the linear correlation of two variables (T and R) when both variables are subject to error.

Given: Equation I

$$(T - A)t = U$$

where

T = mean hourly incubation temperature

A = alpha threshold of development

t = mean hours of incubation necessary for 50-percent hatching

U = number of developmental units necessary for 50-percent hatching

Then: Equation II

$$A = \frac{(W + V/U^2)(T - UR)}{(W + V/U^2)}$$

where

$$W = 4$$

(estimated on the basis of the accuracy with which the thermograph could be adjusted and read)

$$V = \frac{3n_t t^4}{nv_b + 3v_w}$$

(three times the number of zygotes which hatched, times the fourth power of the mean hours of incubation, divided by the number which hatched, times the pooled between variance of the hatching times, plus three times the within variance of the hatching times)

$$R = 1/t$$

(reciprocal of the mean hours of incubation)

Then: Equation III

$$2[(W + V/U^2) R (A + UR - T) - V/U^3 (A + UR - T)^2] = 0$$

T, V, R, and W values were calculated for each kind of larvae for each of the 11 experiments. A 7094 digital computer was programmed to select all T, V, R, and W values for one kind of larva and to determine by a trial-and-error method the U value that best satisfied equation III.

An estimate of the goodness of fit of T and R values to the linear regression line U was determined by this equation:

$$S = (W + V/U^2) (A + UR - T)^2$$

Only two experiments were conducted using warmouth eggs, and the mean incubation temperatures of these two experiments differed by only 0.3° C. Consequently, the alpha thresholds and the numbers of developmental units necessary for 50-percent hatching of warmouth and the three kinds of hybrid zygotes produced from warmouth eggs are not reliable. The alpha thresholds, numbers of developmental units necessary for 50-percent hatching, and S values for the other 12 kinds of zygotes are presented in Table 10.

The *t* test comparisons revealed that

¹Professor of Statistical Design and Analysis, Animal Science Department, University of Illinois, Urbana.

Table 10.—Alpha temperature thresholds of development and numbers of developmental units (degree-hours of effective temperature) necessary for 50-percent hatching of red-ear sunfish, bluegill, green sunfish, and nine different kinds of hybrid sunfish zygotes. (See Tables 5–8 for mean incubation temperatures.)

Parent Species ^a	Number of Eggs that Hatched	Alpha Threshold		U Values (Degree-hours of Effective Temperature)		S Values†
		Degrees Centigrade	Degrees Fahrenheit	Centigrade Scale	Fahrenheit Scale	
♂ x ♀						
R x R	202	18.3	64.9	280	504	7.76
B x R	211	18.3	64.9	290	522	0.16
G x R	255	17.8	64.0	302	543	1.05
W x R	175	18.1	64.5	284	511	6.32
B x B	592	18.3	64.9	287	516	1.52
R x B	638	17.9	64.2	299	538	20.73
G x B	559	18.5	65.3	279	503	6.58
W x B	429	18.1	64.6	249	448	7.33
G x G	498	18.5	65.3	266	478	0.54
R x G	481	18.3	64.9	267	481	24.21
B x G	432	18.6	65.5	258	464	7.80
W x G	513	18.6	65.4	258	464	5.08

^aR = red-ear sunfish, B = bluegill, G = green sunfish, W = warmouth.

†S values can be considered equivalent to Chi square values, and S values larger than 3.83 indicate that the deviations of T and R values from their linear regression line U are significantly greater (0.05 probability level) than deviations due to chance.

the alpha thresholds of development of the 12 kinds of fishes were not significantly different from one another. The alpha thresholds ranged from 17.8° to 18.6° C. (64.0°–65.5° F.) and the mean alpha threshold for all 12 kinds of fishes was 18.3° C.(64.9° F.). Approximately 280 developmental units centigrade scale or 500 units Fahrenheit scale were necessary for 50-percent hatching.

The S values for bluegills, green sunfish, BR F₁ hybrids, and GR F₁ hybrids indicate that the magnitude of the deviations of the weighted T and R values from their respective linear regression lines, U, are within the range that can be attributed to chance. S values for the other eight kinds of fishes indicate that the deviations of their T and R values from U are greater than can be attributed to chance.

Why these greater-than-expected deviations occurred is not known; however, if the relation of incubation temperature to the reciprocal of hatching time is linear for median effective temperatures (Allee et al. 1949:109)

and if the values of the statistical weights V and W were correctly estimated, differences in the sizes of eggs from different females or environmental differences such as carbon dioxide and oxygen tensions could be responsible for such deviations.

Differences in the sizes of eggs undoubtedly result in differences in time of hatching. Newly hatched larvae from large eggs are larger than those from small eggs, and Larimore (1957: 45–46) noted that warmouth larvae emerging from eggs early during the hatching period were smaller (2.30–2.60 mm in total length) than those emerging later (2.65–2.85 mm in total length). Consequently, if eggs were incubated under similar conditions, small eggs would hatch in less time than large eggs.

Alderdice, Wickett, & Brett (1958: 229) found that Pacific salmon eggs exposed to low dissolved oxygen levels just prior to hatching hatched prematurely. Low dissolved oxygen levels may affect sunfish eggs in the same manner.

In the 11 experiments reported here, a high positive correlation between high mortality prior to hatching and premature hatching should be apparent if environmental dissolved oxygen levels became critical enough to affect the time of hatching. An inspection of the data revealed no such correlation; consequently, in these experiments differences in the sizes of eggs from different females appear to be a more likely source of experimental error than low levels of environmental dissolved oxygen.

Isolation Experiments

Thirty-two isolation experiments were conducted from 1957 through 1963. Sixteen of these experiments, all of which involved intrageneric *Lepomis* matings, were reported by Childers & Bennett (1961:6).

METHODS AND MATERIALS.—Males of one species and females of a different species were isolated in small earthen ponds (0.02–0.90 acres). Each of the 12 possible hybrid-producing combinations was tested in one or more ponds. Shortly before the ponds were stocked with the parent species, each pond was drained or treated with rotenone to eliminate any fish which might be present. Parent species were stocked during late May or early June and the ponds were checked at approximately monthly intervals throughout the summer.

The following August or September each pond was drained, seined, or treated with rotenone, and small fish (if present) were identified. Three of the 32 ponds had become contaminated with other fish, and two ponds dried up during the late summer. No hybrids were found in these five ponds. Results of the other 27 experiments are reported in Table 11.

RESULTS AND DISCUSSION.—R x G, G x B, and W x G pairings successfully hybridized each time they were tested. R x G and G x B were each tested in two ponds and W x G was tested in one.

The B x G cross, not included in Table 11, was attempted in two ponds. Both ponds became contaminated with male green sunfish, and large numbers of green sunfish young were produced in both ponds. Consequently, both experiments gave no test of hybridization between bluegill males and green sunfish females.

The R x B cross was attempted in four ponds. No hybrids were produced in three ponds although the ponds remained full and were uncontaminated by other fishes. Eleven small fish were found when the fourth pond was drained, and these fish were believed to have been RB F₁ hybrids although they were not positively identified as such (Childers & Bennett 1961:6). The water in this pond contained a high and constant clay turbidity that reduced the transparency of the water and caused the parent fish to be extremely pale in body color. The normally scarlet portions of the opercle tabs of the red-ear males appeared as a faint rose color. The R x B cross has been attempted three times in Indiana without obtaining offspring (Krumholz 1950:113).

The B x R cross was set up in four ponds. Three of these (not included in Table 11) were improper because of contamination by bluegill females in one and complete loss of water in the other two during the late summer. The fourth test appeared to have been valid but no hybrids were produced.

Smitherman & Hester (1962:335, 337) attempted R x B and B x R crosses by stocking single pairs in plastic pools 9 feet in diameter and 2.5 feet deep. Each cross was attempted in two pools, and hybridization failed to occur in all four trials. In contrast to these results, the B x R cross has been productive of hybrids six times in Indiana (Krumholz 1950:113).

Adults for the R x W cross were stocked in two ponds. One pond became contaminated with male and female green sunfish, and when the

Table 11.—Results of isolation experiments. Adult males of one species and females of another were isolated in each pond in May or June, and ponds were censused in August or September, 1957–1963.

<i>P₁ Cross</i> ^o	<i>Pond Surface Area in Acres</i>	<i>Number of Adults Stocked</i>		<i>Results</i>
		♂	♀	
♂ × ♀				
R × B	0.02	4	6	11 young found†
R × B	0.10‡	15	10	No hybrids
R × B	0.10‡	13	15	No hybrids
R × B	0.80‡	16	11	No hybrids
B × R	0.25‡	8	22	No hybrids
R × G	0.02	4	7	Hybrids abundant
R × G	0.04	8	3	Hybrids abundant
G × R	0.10	2	8	No hybrids
G × R	0.02	4	6	No hybrids
G × R	0.10‡	8	11	No hybrids
G × B	0.02	4	6	Hybrids abundant
G × B	0.90	30	35	Hybrids abundant
W × R	0.20	12	4	No hybrids
W × R	0.20	6	19	No hybrids
R × W	0.75‡	13	6	No hybrids
R × W	0.25‡	12	28	Contaminated§
W × B	0.02	4	5	No hybrids
W × B	0.02	4	5	No hybrids
W × B	0.02	4	5	No hybrids
W × B	0.02	4	5	No hybrids
B × W	0.02	6	5	No hybrids
B × W	0.02	5	3	No hybrids
B × W	0.02	5	3	No hybrids
B × W	0.02	3	2	No hybrids
W × G	0.02	4	6	Hybrids abundant
G × W	0.10‡	8	8	No hybrids
G × W	0.02	4	6	No hybrids

^oR = red-ear sunfish, B = bluegill, G = green sunfish, W = warmouth.

†The 11 young sunfish were believed to be hybrids but were not positively identified as such.

‡Size of pond estimated.

§This pond was contaminated with green sunfish. No RW hybrids were found, but young RG hybrids were found.

pond was seined during September, it contained large numbers of young-of-the-year green sunfish and RG or GR F₁ hybrids. No RW hybrids were found in either pond.

Although the R × W cross was unsuccessful in these experiments, I found a large natural population of RW hybrids in a 2-acre farm pond near Fairmount, Ill. This pond was stocked in 1952 with warmouths, red-ear sunfish, and smallmouth bass. No hybrids were found during 1953 or 1954. During March, 1955, all three species in this pond suffered extensive mortality be-

cause of critical dissolved oxygen conditions. A large population of RW hybrids was produced following this spring mortality. Since stripping experiments indicated the W × R cross resulted in nonviable hybrids, the natural hybrid population was apparently produced by male red-ears and female warmouths.

The G × R (three tests), W × R (two tests), W × B (four tests), B × W (four tests), and G × W (two tests) all failed to produce hybrid populations although the parent species had good opportunities to hybridize in each test.

In each of the 32 isolation experiments males constructed nests and remained in spawning condition for extended periods throughout the summer. The failure of certain P_1 crosses to hybridize was believed to result from incompatibilities in the reproductive behavior patterns of the various species and not because males and females failed to be in spawning condition at the same time.

Fish hybridization might result from sperm driftage or interspecific matings. Sperm driftage is an important cause of hybridization among certain species of fishes, particularly minnows and darters, which live in flowing water habitats and simultaneously spawn in close proximity to one another (Hubbs 1955: 10, 16). Sperm driftage may also account for some hybridization between pond- or lake-dwelling centrarchids; however, since average functional life spans of sunfish spermatozoans are so brief (Tables 2-4) and since there is such good synchronization in the release of sperm and eggs by a spawning pair, most hybrid sunfish are probably the result of interspecific pair formation.

The four experimental species are sexually dimorphic, closely allied, sympatric species. Signals that are in some way involved in reproductive isolation of such species are likely to be highly divergent (Marler 1957:35) and may involve specific differences in shape, color, special movements, sounds, scents, etc. (Tinbergen 1951:56). The precise signals which are operative in conspecific pair formation of the four experimental species are not known; however, specific differences in color of opercle tabs, eyes, cheeks, and pelvic fins of nest-guarding males (Table 1) may be important in controlling the behavior of ripe females. When a female ready to spawn approaches a nest-guarding male, she usually stops some distance from the nest and the male exhibits a courtship display (Miller 1963:118). Species recognition appar-

ently occurs during this short time, and the female flees or remains in the vicinity of the nest and accepts the advances of the male.

Since in one isolation experiment there was an indication that the scarlet portions of the opercular tabs of male red-ear sunfish might possibly prevent hybridization between male red-ears and female bluegills, an experiment was conducted during 1964 to test this hypothesis. Two small earthen ponds (25 feet wide, 45 feet long, with a maximum depth of 4 feet) were each stocked during July with three ripe adult male red-ear sunfish and three adult female bluegills. The opercular tabs were clipped from all males stocked in one pond, and the tabs were left intact on the males stocked in the other pond.

The ponds were drained during early October, and several thousand small (0.5-1.0 inch in total length) hybrid fry were collected from the pond containing red-ear males whose opercular tabs had been removed. No small fish were found in the control pond. An examination of the clipped males revealed that the blue portion of the opercular tabs had regenerated to almost normal size but the scarlet portions had not regenerated. One tab on each of these males had a small, narrow, yellowish-orange margin.

One such test cannot, of course, be considered conclusive proof that specific differences in the color of the opercular tabs of male red-ears are highly functional in preventing their hybridization with female bluegills; however, additional investigation of the importance of color as a reproductive isolating mechanism in the sunfishes might prove rewarding.

According to Hubbs (1957:17), fish hybridization is controlled to a large extent by environmental factors. Sunfish hybrids appear to be more common in ponds which are choked with aquatic vegetation or have high turbidities than in clear-water ponds which have ex-

tensive spawning areas free from vegetation. In weed-choked ponds or ponds with high turbidities the range of visibility must be short, and under these conditions ripe females might occasionally spawn with males without observing preliminary courtship displays believed to be important in conspecific pair formation.

HYBRIDS REARED IN PONDS

Large numbers of each of the 10 viable F_1 hybrid types were stocked in one or more ponds. Most of these hybrids were produced in the laboratory by combining sex products stripped from ripe adults of the four parent species. However, a few were produced by isolating males of one species and females of another species in ponds which contained no other fish. The laboratory hybrids were stocked on the day they became free-swimming; the pond-produced hybrids were seined and stocked in other ponds when they had attained a length of about 1 inch.

The F_1 hybrids were reared to maturity in their respective ponds and the sex ratio, fecundity, and degree of heterosis of each F_1 hybrid population were studied.

Sex Ratios

After the F_1 hybrids had grown to sexual maturity, fish were collected from each population and sexed, mostly by dissection. However, some were sexed by stripping eggs or milt from ripe individuals, and fewer still were sexed by reference to color, size of abdomen, and comparative size and shape of anus and urogenital openings.

The sex of a mature sunfish is not difficult to determine by observation during the spawning period. Male sunfish are usually more vividly colored than females. The abdominal region of females becomes greatly distended with eggs shortly before spawning occurs. The diameter of the urogenital opening in male sunfish is usually less than one-

half the diameter of the anus, but in females it is equal to or larger than the diameter of the anus. In male sunfish the urogenital opening forms a cup-shaped depression and in females it forms a small papilla.

If there was any doubt as to the sex of a particular individual, that individual was dissected. The accuracy of determining sex by observation was checked several times by dissecting all fish in a particular sample in which the fish had been previously sexed by observation. No errors were revealed.

The sex ratios, expressed as the percentage of males, for each of the 10 different kinds of viable F_1 hybrids produced from the four experimental species are reported in Table 12. Sex ratios determined for population of the six intrageneric *Lepomis* hybrids reported by Childers & Bennett (1961:7) are included in Table 12.

Table 12.—Sex ratios of F_1 hybrid sunfishes expressed as the percentage of males in individual populations.

F_1 Hybrid Populations*	Where Produced†	Number Sexed	Percent Male
RB	L	178	100
RB	L	197	100‡
RB	L	95	87
		470	97
BR	L	110	97
RG	L	457	69
GR	L	252	48
BG	L	142	97
GB	P	44	70
GB	P	22	64
		66	68
RW	L	174	55
BW	L	101	66
BW	L	302	70
		403	69
GW	L	147	16
WG	P	104	84

*R=red-ear sunfish, B=bluegill, G=green sunfish, W=Warmouth. In names of hybrids the male parent species is given first.

†L=laboratory-produced hybrids and P=pond-produced hybrids.

‡One F_1 hybrid was collected from this pond; so at least one female was in this population.



RED-EAR SUNFISH



BLUEGILL



GREEN SUNFISH



D



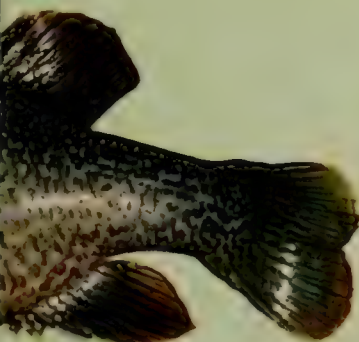
F₁ HYBRID



ID



F₁ HYBRID



ID



F₁ HYBRID



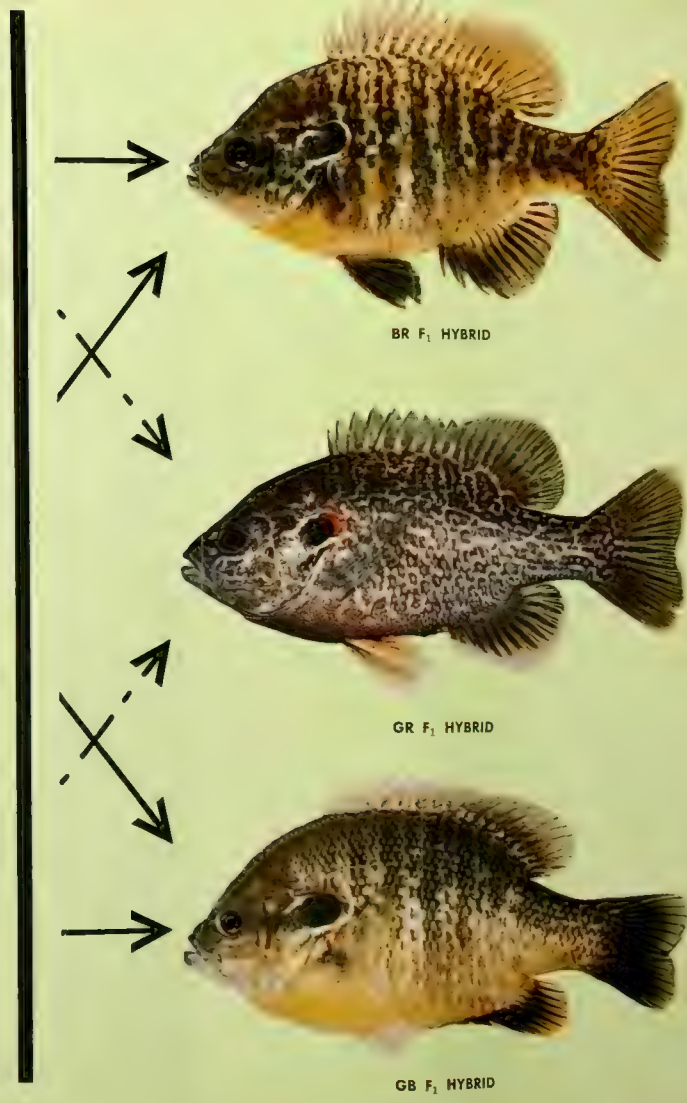
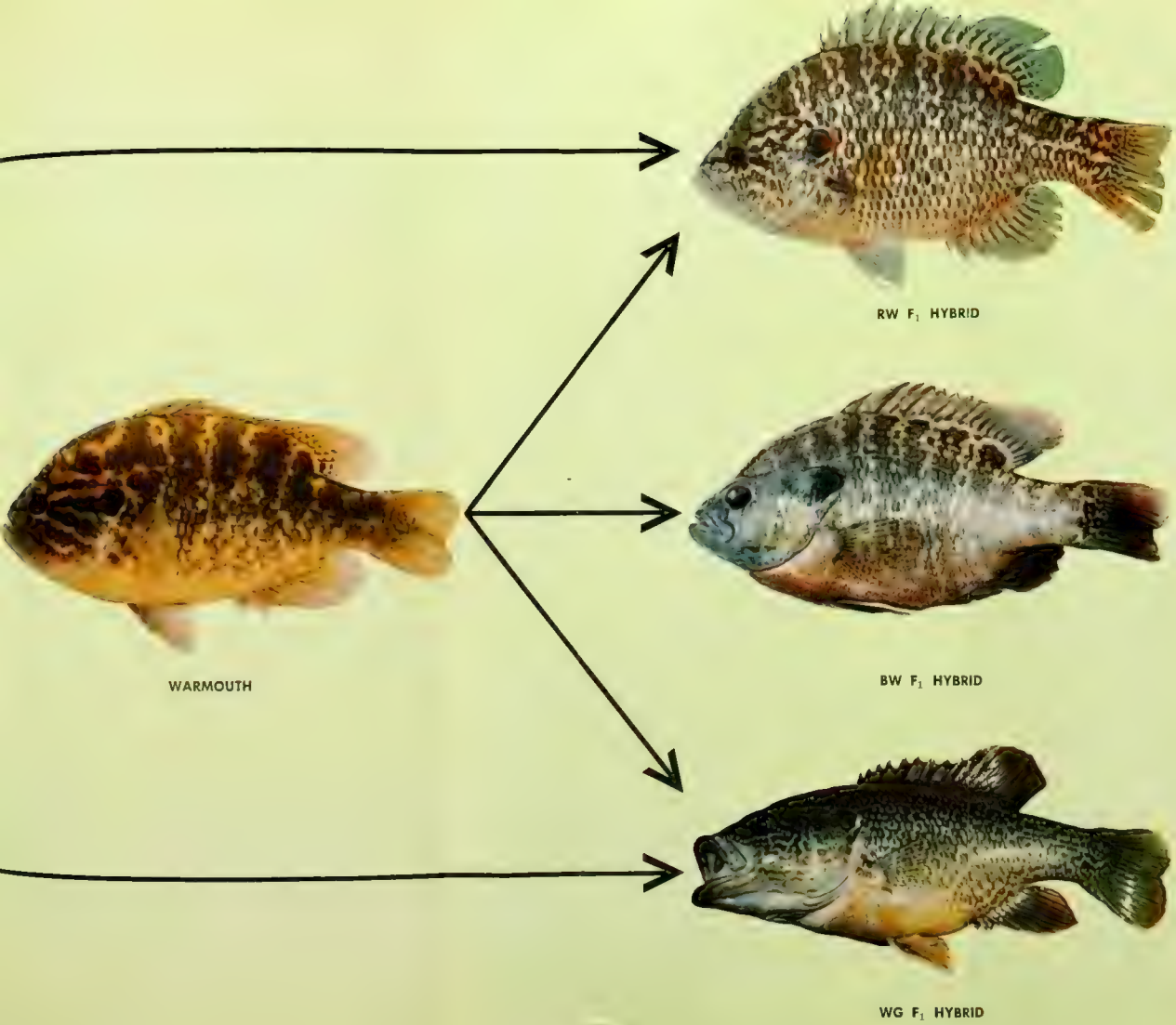
RED-EAR SUNFISH



BLUEGILL



GREEN SUNFISH



Of the 10 kinds of viable F_1 hybrids, seven were predominately males (RB, BR, and BG were 97 percent males; WG were 84 percent males; and RG, GB, and BW were approximately 70 percent males), two were approximately 50 percent males (GR and RW), and one was predominately female (GW was 16 percent males). Ricker (1948:93-94) determined the sex of 428 BR F_1 hybrids in Indiana and found them to be 97.7 percent males.

Sex determination in sunfishes is very poorly understood. Bluegills, green sunfish, and their F_1 hybrids apparently have 24 pairs of chromosomes, and the sex chromosomes are indistinguishable from the autosomes (Bright 1937:36). Bright (1937:26) also reported that the chromosomes are so similar in shape and size that he was unable to detect specific differences. Roberts (1964:402) found that red-ear, bluegill, and warmouth sunfishes each have 24 pairs of chromosomes; green sunfish from Wake County, N.C., had 24 pairs; but green sunfish from Leetown, W.Va., had only 23 pairs.

The unbalanced phenotypic tertiary¹ sex ratios of the F_1 hybrid sunfish could result from unbalance primary genetic sex ratios, specific differences in the strength of sex-determining factors, an overriding of the genetic sex by environmental factors, or differential mortality of the sexes.

Since the WG F_1 hybrids were 84 percent males and the reciprocal cross hybrids were 16 percent males, it is possible that the strength of sex-determining factors of warmouths are 5.25 times more powerful than those of green sunfish. Specific differences in the strength of sex-determining factors cannot alone explain the sex ratios of the remaining eight kinds of viable hybrids,

since none of these were predominantly females.

RB and BG F_1 hybrids were both 97 percent males. If differential mortality were the cause of these unbalanced sex ratios, much of the mortality would have had to occur after the swim-up fry stage, since in the stripping experiments total mortality between fertilization and the swim-up fry stages was only 14 percent for the RB and 27 percent for the BG F_1 hybrids.

It is not known which sex is the heterozygous condition for the sex chromosomes of the four experimental species; however, Haldane (1922:108) formulated a rule which furnishes a clue.

When in the F_1 offspring of a cross between two animal species or races, one sex is absent, rare, or sterile, that sex is always the heterozygous sex.

Using Haldane's rule, Krumholz (1950:114), in a study concerning BR F_1 hybrids, pointed out that the males of both bluegills and red-ear sunfish are probably homozygous for sex and the females heterozygous. The application of Haldane's rule to all possible F_1 hybrids produced from red-ear sunfish, bluegills, and green sunfish indicates that the female is the heterozygous sex in these three species. Hybridization of male warmouths with females of the three *Lepomis* species resulted in partial or complete lethals, suggesting that in the warmouth the male is the heterogametic sex.

Fecundities

The reproductive success of each of the 10 kinds of viable F_1 hybrids was investigated in one or more ponds. The occurrence and abundance of F_2 hybrids were determined by seining, trapping, shocking, poisoning, or draining the ponds after the F_1 hybrids were 1 or more years of age. Eighteen separate populations were studied. The results of these studies are presented in Table 13.

Of the 10 kinds of viable F_1 hybrids,

¹In this paper the terms primary, secondary, and tertiary sex ratios refer to sex ratios at the time of fertilization, time of hatching, and time of sexual maturity, respectively. Genetic sex refers to the type of sex chromosomes an individual receives from its parents, and phenotypic sex refers to whether its gonads are testes or ovaries.

Table 13.—The occurrence and estimated abundance of F_2 hybrids in ponds stocked with F_1 hybrids.

F_1 Hybrid ^a	Pond	Abundance of F_2 Hybrids	Other Species Present
RB	1	None found	None
RB	2	None found	None
RB	3	One individual found	Hybrid crappies
BR	4	None found	None
RG	5	Abundant	None
RG	6	Abundant	None
RG	7	Scarce	Largemouth bass
GR	8	Scarce to abundant†	None
BG	9	None found	None
GB	10	Abundant	None
GB	11	Scarce	Largemouth bass
RW	18	Abundant	None
BW	15	None found	Largemouth bass
BW	16	Abundant	Hybrid crappies
BW	17	Scarce‡	Largemouth bass, bluegills, lake chubsuckers, warmouths, channel catfish
GW	12	Abundant	None
GW	13	Fairly abundant	Largemouth bass and bluegills
WG	14	Abundant	None

^aR = red-ear sunfish, B = bluegill, G = green sunfish, W = warmouth. In names of hybrids the male parent species is given first.

†When the F_1 hybrid population was dense, only a few F_2 hybrids were found. The number of F_2 hybrids was drastically reduced and the few remaining F_1 hybrids produced a large number of F_2 hybrids the following year.

‡These fish were believed to be F_2 hybrids; however, they could have been produced by the F_1 hybrids backcrossing to either of their parent species.

RB, BR, and BG failed to produce abundant F_2 generations when in ponds which contained no other species of fishes. In contrast to these results, BR F_1 hybrids produced abundant F_2 generations in two ponds in Indiana (Ricker 1948:94). Six of the other seven kinds of F_1 hybrids produced abundant F_2 hybrids when in ponds which contained no other species of fishes, and the seventh, stocked in a pond with F_1 hybrid crappies, also produced a large F_2 generation.

Three of the seven kinds of F_1 hybrids which produced large F_2 populations when stocked in ponds containing either no other fishes or hybrid crappies were also stocked in ponds with largemouth bass. RG F_1 hybrids and GB F_1 hybrids, when stocked with largemouth bass, produced only a few F_2 hybrids. No F_2

hybrids were found in the pond stocked with BW F_1 hybrids and largemouth bass. Only a few BW F_2 hybrids were found when an 18-acre lake containing BW F_1 hybrids; largemouth bass; warmouths; bluegills; channel catfish, *Ictalurus punctatus* (Rafinesque); and lake chubsuckers, *Erimyzon sucetta* (Lacépède), was drained.

The results of these experiments, although not conclusive because of the small number of trials, do indicate that RG, GB, and BW F_1 hybrids which are capable of producing large F_2 populations in ponds containing either no other species or hybrid crappies are unable to do so in ponds containing largemouth bass. It is not known whether scarcities of F_2 hybrids in ponds containing largemouth bass are the result of low fecundity of F_1 hybrids or a high vulnerability of F_2

hybrids to bass predation. Both possible causes may be important. Hale (1956: 105) found that green sunfish with forebrain lesions exhibited a marked reduction in their ability to learn to negotiate a maze. It would be interesting to know if the forebrains of the F₂ hybrids are structurally or functionally different from those of F₁ hybrids or their parent species.

WG F₂ hybrids, stocked in a pond which contained no other fishes, produced a large F₃ generation. GW F₂ hybrids, which were stocked in a pond containing no other fishes, also produced a large F₃ population.

Backcrosses, outcrosses, a four-species cross, and a three-species cross involving F₁ hybrids are listed in Table 14. The BW x B backcross was made by stocking adult male BW F₁ hybrids and adult female bluegills in a pond which contained no other fishes. The other 12 crosses listed in Table 14 were made by stripping gametes from ripe adults and rearing the young to the free-swimming fry stage in the laboratory.

R x RW, W x RW, B x RW, G x RW, R x GB, and RB' x W young were killed after they developed into free-swimming fry because of the lack of ponds in which they could be stocked. All six kinds of fry appeared to be normal and probably would have developed into

adults. Free-swimming fry of the remaining six crosses in the laboratory were stocked in ponds and did develop into adult fishes. BW x B, G x GW, and B x RG populations produced large numbers of young.

Hubbs & Hubbs (1933:631-636) reported that in Michigan F₁ hybrids of bluegills, green sunfish, longear sunfish, pumpkinseeds, and orangespotted sunfish were unable to reproduce because males were sterile and ova stripped from the few adult females used in the experiments appeared distinctly abnormal. This study, often cited in the literature, has resulted in a rather widespread belief that all male hybrid sunfish are sterile. Results of my experiments conclusively establish that a number of different kinds of hybrid sunfishes produced in Illinois are not sterile, are fully capable of producing abundant F₂ and F₃ generations, and can be successfully backcrossed to parent species and even outcrossed to nonparental species.

Hybrid Vigor

Heterosis has been defined (Manwell, Baker, & Childers 1963:103) as that condition where, with respect to one or more particular characteristics, the values for most, if not all, of the individual hybrids fall significantly outside the range formed from the means for both parent populations. In cases of positive heterosis—hybrid vigor—the hybrid shows a faster growth rate than either of the parents, or it possesses some other characteristic, often an economically significant one, at a "better" level than the parents do.

RATE OF GROWTH.—The growth of the different kinds of hybrids stocked in ponds was recorded for each of the populations mentioned in Tables 12 and 13. Since various numbers (200-10,000 per surface acre) of hybrids were stocked and since the ponds differed in size, depth, shape of basin, and fertility, no valid comparisons can be made between the growth rates of the hybrids or between those of the hybrids and their parent species. In general the rates of growth of these hybrids were inversely proportional to

Table 14.—Successful backcrosses, outcrosses, four-way cross, and another cross involving F₁ hybrid sunfishes.*

Backcrosses	Outcrosses	Four-Species Cross	Three-Species Cross
♂ x ♀	♂ x ♀	♂ x ♀	♂ x ♀
R x RW	R x GB	RB x GW	BW x GW
G x GW	R x BW		
W x RW	R x GW		
BW x B	B x RG		
	B x RW		
	G x RW		
	RB x W		

*R = red-ear sunfish, B = bluegill, G = green sunfish, W = warmouth.

their population densities. The most rapid growth during the 1st year of life occurred in a 1-acre pond stocked on May 24, 1957, with approximately 1,000 free-swimming, laboratory-produced, 1-day-old RW F_1 hybrid fry. Approximately $4\frac{1}{2}$ months later, October 8, 66 hybrids from this population averaged 145 mm (5.7 inches) in total length and 69 grams (0.15 pound).

The slowest growth occurred in a 0.1-acre pond stocked on May 27, 1957, with approximately 1,000 (10,000 per surface acre) 1-day-old, free-swimming, laboratory-produced GR F_1 hybrid fry. On August 30, 106 hybrids from this population averaged only 94 mm (3.7 inches) total length. The fish in this sample were not weighed; however, based on the weights of fish of similar lengths from later samples, the calculated average weight of fish from the August 30th collection was about 15 grams (0.03 pound).

The largest hybrid captured to date (May, 1965) was a 6-year-old GB F_1 hybrid whose total length was 310 mm and weight was 965 grams (Frontis-piece).

Hubbs & Hubbs (1931:291, 296-297) during 1929 and 1930 studied the growth of pumpkinseed, green sunfish, and the naturally produced hybrid of these two species in Wiard's pond near Ypsilanti, Mich. Average lengths of both 1- and 2-year-old hybrids in this pond were greater than those of either parent species. The effect on growth of the relative abundance of the three kinds of fishes in this pond (pumpkinseeds, green sunfish, and their hybrids) was not considered. Based on the total number of individuals reported, pumpkinseeds were approximately 10 times more abundant than green sunfish and green sunfish twice as abundant as hybrids. Intraspecific competition is usually keener than interspecific competition because individuals of the same species are more nearly equal in their structural, functional, and be-

havioral adaptations (Kendeigh 1961: 183). Consequently, the greater growth of the hybrid sunfish in Wiard's pond may have been the result of less intraspecific competition among the hybrids than among the parent species and not because the hybrids exhibited hybrid vigor.

In an attempt to determine whether certain F_1 hybrid sunfishes actually grow faster than their parent species, two experiments were conducted in which equal numbers of uniformly sized F_1 hybrids and parent species were stocked in ponds which contained no other fishes (Childers & Bennett 1961:11-13). In the first experiment, 171 BG F_1 hybrids and 171 green sunfish averaging about 25 mm (1.0 inch) and 19 mm (0.75 inch), respectively, were stocked on July 10, 1958, in an 0.8-acre gravel pit pond. Ten months later (during 4 months of which the waters were warm enough for fish growth) fish were removed from the pond by trapping and rotenone poisoning.

In the second experiment 200 GR F_1 hybrids, 200 green sunfish, and 200 red-ear sunfish averaging 117 mm (4.6 inches), 107 mm (4.2 inches), and 89 mm (3.5 inches), respectively, were stocked in a 1.1-acre farm pond during early August, 1958. Fish were removed from this pond April 20 through May 25, 1959, by hook-and-line fishing, trapping, and rotenone poisoning.

In both experiments the average increase in total length of the hybrids was not significantly different from the increases of the parental species. The population densities of the fishes in both ponds were much lower than would be found in most normal natural populations. In both experiments intraspecific and interspecific competition was undoubtedly quite light; consequently, the question of whether certain F_1 hybrid sunfishes are superior to their parent species in rate of growth cannot be answered until high density

populations containing equal numbers of equal-sized hybrids and parent species are studied.

ELECTROPHORETIC PATTERNS OF HEMOGLOBINS.—Manwell, Baker, & Childers (1963:118–119) determined that redear sunfish, bluegills, green sunfish, and warmouths each have a hemoglobin pattern in vertical starch gel electrophoresis that is unique. Almost every one of the F_1 hybrids of these species yields a hemoglobin pattern that is identical with that obtained by simply mixing hemoglobins of the two parental species; however, from 25 to 40 percent of the hemoglobin from BW, GW, and WG F_1 hybrids has electrophoretic properties different from the hemoglobins of the parental species. Oxygen equilibria for the hemoglobins from these three hybrids show greater heme-heme interactions than those for hemoglobin from any of their parental species. As a result of this greater heme-heme interaction, hemoglobins from these three hybrids have better blood gas transport properties than those of their parental species, and in this respect each of these three hybrids is believed to exhibit hybrid vigor.

VULNERABILITY TO HOOK-AND-LINE CAPTURE.—Although no controlled experiment has tested whether F_1 hybrid sunfishes are more vulnerable to angling than their parental species, certain F_1 hybrids are so easily caught that at several locations sport fishermen have almost completely eliminated substantial hybrid sunfish populations in a few days of angling.

For example, on May 30, 1958, the Illinois Department of Conservation opened the lake at Lincoln Trail State Park near Marshall to public fishing. From May 30 through September 29, fishermen caught and removed approximately 10,800 naturally produced BG or GB F_1 hybrids of which 50 percent (5,400) were caught during the 1st day of fishing, and 82 percent (8,600) were removed during the first

3 days. This hybrid sunfish population was almost completely eliminated during the 1st week of fishing.

Ridge Lake, an 18-acre lake in Fox Ridge State Park near Charleston, Ill., was drained during the fall of 1959 and fish were moved to other waters. In the spring of 1960, the lake was restocked with 4,503 BW F_1 hybrids, 299 largemouth bass, 41 channel catfish, and 585 lake chubsuckers. An additional 448 RW F_1 hybrids were stocked in May, 1961.

A limited number of fishermen was permitted to fish during June, July, and August of 1960, 1961, and 1962. During 1960, fishermen totaled 1,583 man-hours of fishing and caught 3,772 of these hybrids, of which 64 were removed and 3,708 returned to the lake. In 1961 fishermen totaled 2,830 man-hours of fishing and caught 4,890 hybrids, of which 194 BW and 6 RW hybrids were removed. The remaining 4,690 hybrids were returned to the lake. The next season (1962) fishermen were permitted to remove all the hybrids they caught, and during 2,817 man-hours of fishing they removed 1,075 BW and 134 RW F_1 hybrids. Of these 1,209 hybrids, 65 percent were caught during the first 5 days of fishing, 81 percent during the first 10 days, and 88 percent during the first 15 days. The lake was drained during March, 1963, and was found to contain 8 BW and 64 RW F_1 hybrids.

HYBRID SUNFISHES FOR SPORT FISHING

Overpopulation of sunfish is the single greatest problem encountered in the management of Illinois lakes and ponds containing largemouth bass and one or more of the *Lepomis* species. The *Lepomis* species have such high reproductive capacities and survival capabilities that they commonly become so abundant that they are unable to grow to sizes large enough to be of value to fishermen. Because certain

kinds of F_1 hybrid sunfishes appear to be unable to produce sizable F_2 populations in ponds containing largemouth bass, a number of experiments are now in progress to test the usefulness of hybrids in combination with largemouths. Preliminary results indicate that several types of hybrids in combination with bass furnish fishing superior to that furnished by bass in combination with the hybrids' parent species.

SUMMARY

1.—Red-ear sunfish, *Lepomis microlophus* (Günther); bluegill, *L. macrochirus* Rafinesque; green sunfish, *L. cyanellus* Rafinesque; and warmouth, *Chaenobryttus gulosus* (Cuvier) are present in a number of east-central Illinois lakes and ponds and are known to hybridize occasionally. During 1957 through 1964, the spawning seasons of these species were observed to extend from mid-May to August or September.

2.—Red-ear sunfish, bluegills, and green sunfish usually nested in colonies, and mixed colonies containing two and, less frequently, all three of these species were not uncommon. Warmouths tended to be more solitary in their nest site selections.

3.—Results of laboratory experiments indicate that average functional life spans of bluegill, green sunfish, and warmouth gametes are approximately 1 hour for ova and 1 minute for spermatozoa. The brief functional life spans of spermatozoa are undoubtedly important in reducing hybridization caused by sperm driftage.

4.—Gametes stripped from the four species were paired in 16 different combinations to produce zygotes representing 12 kinds of F_1 hybrids and the four parental species. $W\delta \times B\varnothing^1$ and $W\delta \times R\varnothing$ crosses were 100 percent lethal and the $W\delta \times G\varnothing$ cross was partially lethal. Based on the percent-

ages of zygotes that hatched and developed into normal-appearing fry, the viability of each of the remaining nine kinds of hybrids was not significantly different from that of its maternal parent. $B\delta R\varnothing$ and $G\delta R\varnothing$ hybrid fry were significantly longer bodied than pure red-ear fry of comparable ages. The other eight kinds of hybrid fry were not significantly different in length from their respective maternal parent fry of comparable ages.

5.—Alpha temperature thresholds of development for red-ear sunfish, bluegills, green sunfish, and nine kinds of hybrids were not significantly different from one another. The mean alpha threshold for all 12 kinds of fishes was 18.3°C. (64.9°F.). Approximately 280 developmental units (degree-hours of effective temperature) centigrade scale or 500 units Fahrenheit scale were necessary for 50-percent hatching.

6.—Adult males of one species and adult females of another species were isolated in ponds to determine which of the 12 possible crosses may occur in nature. Thirty-four such experiments were conducted. Only $R\delta \times G\varnothing$, $G\delta \times B\varnothing$, and $W\delta \times G\varnothing$ crosses (two, two, and one experiment, respectively) produced large F_1 hybrid populations. Female bluegills successfully spawned with red-ear males whose opercular tabs had been removed (one experiment). Spawning did not occur in ponds containing normal red-ear males and female bluegills (five experiments). Results of the remaining 23 experiments were either negative or inconclusive.

7.—Large numbers of each of the 10 kinds of viable F_1 hybrids were stocked in ponds, and after they grew to maturity, the sex ratio and fecundity exhibited by each population were investigated. $R\delta B\varnothing$, $B\delta R\varnothing$, and $B\delta G\varnothing$ were 97 percent males; $W\delta G\varnothing$ was 84 percent males; $R\delta G\varnothing$, $G\delta B\varnothing$, and $B\delta W\varnothing$ were approximately 70 percent males; $G\delta R\varnothing$ and $R\delta W\varnothing$

¹R = red-ear sunfish, B = bluegill, G = green sunfish, W = warmouth.

were 50 percent males; and $G \delta W \varnothing$ were only 16 percent males. When in ponds which contained either no other fishes or only hybrid crappies, only three ($R \delta B \varnothing$, $B \delta R \varnothing$, and $B \delta G \varnothing$) of the 10 kinds of viable F_1 hybrids failed to produce abundant F_2 generations. $R \delta G \varnothing$, $G \delta B \varnothing$, and $B \delta W \varnothing$ F_1 hybrids were also stocked in ponds containing largemouth bass. These three kinds of F_1 hybrids were unable to produce abundant F_2 generations when in combination with largemouths although they did so in ponds where largemouth bass were absent.

8.— $W \delta G \varnothing$ F_2 hybrids isolated in one pond and $G \delta W \varnothing$ F_2 hybrids isolated in another pond produced abundant F_3 generations. Thirteen other crosses involving F_1 hybrids were successful. Free-swimming fry from six of these were sacrificed because ponds were not available in which to stock them. Young from the other seven crosses were reared to 1 or more years of age in ponds, and successful reproduction occurred in three ponds.

9.—Equal numbers of relatively equal-sized $G \delta R \varnothing$ F_1 hybrids, green sunfish, and red-ear sunfish were

stocked in one pond, and $B \delta G \varnothing$ F_1 hybrids and green sunfish were stocked in another pond. When fishes in both ponds were poisoned at later dates, the average increases in total lengths of the hybrids were not significantly different from those of their parental species.

10.—The hemoglobin patterns in vertical starch gel electrophoresis of $B \delta W \varnothing$, $G \delta W \varnothing$ and $W \delta G \varnothing$ F_1 hybrids show marked differences from those of their parental species. The hybrid hemoglobins have better gas transport properties than those of the parental species, and in this respect these three hybrids are believed to exhibit hybrid vigor. The electrophoretic pattern of the hemoglobins of each of the other seven hybrids is identical to that obtained by mixing equal amounts of hemoglobins of the two parental species.

11.— F_1 hybrid sunfishes appear to be highly vulnerable to capture by hook-and-line fishing. Creel censuses indicate that large populations of hybrids can be almost completely eliminated in only a few days when subjected to moderate fishing pressure.

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APPENDIX

Table A1.—Partial chemical analysis of water taken August 2, 1963, from the well on Parkhill's Lake Park Subdivision Number Two, approximately 3 miles south of Champaign, Ill. The water was aerated and filtered through activated charcoal for 1 week prior to the analysis. The water had no measurable color or odor. The pH was 8.8. The analysis was made by the Illinois Water Survey.

<i>Chemical Composition</i>	<i>Parts Per Million</i>
Iron (total)	Trace
Calcium	24
Magnesium	21
Chloride	3
Phenothaline alkalinity (as CaCO ₃)	12
Methyl orange alkalinity (as CaCO ₃)	204
Hardness (as CaCO ₃)	148
Total dissolved minerals	239

Table A2.—Experiment W1: duration of fertility of activated gametes from one pair of warmouths.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Sperm and Eggs				
0.75	0.25	93	47	46
3.15	2.75	211	11	10
5.55	5.25	102	0	0
8.45	7.75	149	0	0
10.35	10.25	86	0	0

*The temperature at time of fertilization was 27.8° C.(82.0° F.). During the entire experiment, 132 hours, the temperature ranged from 26.1° to 27.8° C.(79.0° to 82.0° F.) and averaged 27.2° C.(80.9° F.).
†Fry were free swimming. Only normal fry are included in this figure.

Table A3.—Experiment W2: duration of fertility of activated gametes from one pair of warmouths.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Sperm and Eggs				
0.75	0.25	25	42	35
3.15	2.75	20	0	0
5.55	5.25	48	0	0
8.45	7.75	29	0	0
10.55	10.25	37	0	0

*The temperature at time of fertilization was 27.8° C.(82.0° F.). During the entire experiment, 128 hours, the temperature ranged from 26.1° to 27.8° C.(79.0° to 82.0° F.) and averaged 27.2° C.(80.9° F.).
†Fry were free swimming. Only normal fry are included in this figure.

Table A4.—Experiment W3: duration of fertility of activated eggs from a single female warmouth. Sperm used in this experiment were from a single male.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Eggs				
0.50	0	39	100	95
30.00	0	79	92	90
60.00	0	91	72	70
120.00	0	81	49	48
180.00	0	89	7	2

*The temperature at time of fertilization was 27.2° C.(81.0° F.). During the entire experiment, 100 hours, the temperature ranged from 26.1° to 28.3° C.(79.0° to 83.0° F.) and averaged 27.3° C.(81.1° F.).
†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A5.—Experiment W4: duration of fertility of activated eggs from a single female warmouth. Sperm used in this experiment were from a single male.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Eggs				
0.50	0	89	89	73
30.00	0	82	16	16
60.00	0	81	44	41
120.00	0	69	14	6
180.00	0	89	0	0

*The temperature at time of fertilization was 27.5°C.(81.5° F.). During the entire experiment, 125 hours, the temperature ranged from 26.4° to 27.8° C.(79.5° to 82.0° F.) and averaged 27.0° C.(80.6° F.).
†Fry were free swimming. Only normal fry are included in this figure.

Table A6.—Experiment B1: duration of fertility of activated gametes from one pair of bluegills.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Sperm and Eggs				
1.00	0.25	48	50	33
1.90	1.25	40	45	8
2.80	2.25	38	18	18
3.70	3.25	63	2	2
4.60	4.25	42	0	0
5.50	5.25	27	0	0
Aging of Eggs				
0.50	0	26	85	85
30.00	0	44	75	68
60.00	0	26	38	27
120.00	0	59	22	10
180.00	0	32	0	0

*The temperature at time of fertilization was 23.3° C. (74.0° F.). During the entire experiment, 102 hours, the temperature ranged from 23.0° to 27.2° C. (73.5° to 81.0° F.) and averaged 25.3° C. (77.6° F.).

†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A7.—Experiment B2: duration of fertility of activated gametes from one pair of bluegills.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Sperm and Eggs				
1.00	0.25	44	82	64
1.90	1.25	34	53	44
2.80	2.25	38	5	5
3.70	3.25	22	0	0
4.60	4.25	23	0	0
5.50	5.25	37	0	0

*The temperature at time of fertilization was 23.6° C. (74.5° F.). During the entire experiment, 102 hours, the temperature ranged from 23.0° to 27.2° C. (73.5° to 81.0° F.) and averaged 25.3° C. (77.6° F.).

†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A8.—Experiment B3: duration of fertility of activated eggs from one female bluegill. Sperm used in this experiment were from a single male.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Eggs				
0.50	0	96	96	96
30.00	0	71	82	82
60.00	0	59	51	51
120.00	0	93	16	16
180.00	0	44	20	20

*The temperature at time of fertilization was 26.9° C.(80.5° F.). During the entire experiment, 98 hours, the temperature ranged from 26.1° to 28.3° C.(79.0° to 83.0° F.) and averaged 27.3° C.(81.1° F.).
†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A9.—Experiment B4: duration of fertility of activated eggs from a single female bluegill. Sperm used in this experiment were from a single male.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Eggs				
0.50	0	88	65	61
30.00	0	28	28	28
60.00	0	38	32	32
120.00	0	44	23	23
180.00	0	48	4	0

*The temperature at time of fertilization was 23.9° C.(75.0° F.). During the entire experiment, 138 hours, the temperature ranged from 22.8° to 25.0° C.(73.0° to 77.0° F.) and averaged 24.2° C.(75.5° F.).
†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A10.—Experiment G1: duration of fertility of activated gametes from one pair of green sunfish.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Sperm and Eggs				
1.00	0.25	40	52	50
1.90	1.25	32	6	6
2.80	2.25	34	1	1
3.70	3.25	31	0	0
4.60	4.25	43	0	0
5.50	5.25	38	5	5
Aging of Eggs				
0.50	0	33	91	88
30.00	0	57	24	23
60.00	0	74	8	7
120.00	0	49	4	2
180.00	0	27	7	4

*The temperature at time of fertilization was 23.6° C. (74.5° F.). During the entire experiment, 185 hours, the temperature ranged from 22.8° to 25.0° C. (73.0° to 77.0° F.) and averaged 24.2° C. (75.6° F.).

†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A11.—Experiment G2: duration of fertility of activated gametes from one pair of green sunfish.*

<i>Age of Eggs in Minutes</i>	<i>Age of Sperm in Minutes</i>	<i>Number of Eggs</i>	<i>Percent of Eggs that Hatched</i>	<i>Percent of Eggs that Developed into Fry†</i>
Aging of Sperm and Eggs				
2.25	0.25	79	52	47
3.15	1.25	57	19	18
4.05	2.25	55	2	2
4.95	3.25	81	0	0
5.85	4.25	71	1	1
6.75	5.25	74	0	0
Aging of Eggs				
0.50	0	31	32	32
30.00	0	39	41	36
60.00	0	78	26	23
120.00	0	46	13	13
180.00	0	70	7	6

*The temperature at time of fertilization was 23.6° C. (74.5° F.). During the entire experiment, 185 hours, the temperature ranged from 22.8° to 25.0° C. (73.0° to 77.0° F.) and averaged 24.2° C. (75.6° F.).

†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A12.—Experiment G3: duration of fertility of activated gametes from one pair of green sunfish.*

Age of Eggs in Minutes	Age of Sperm in Minutes	Number of Eggs	Percent of Eggs that Hatched	Percent of Eggs that Developed into Fry†
Aging of Sperm and Eggs				
1.00	0.25	44	36	34
1.90	1.25	52	25	25
2.80	2.25	16	0	0
3.70	3.25	111	5	4
4.60	4.25	25	4	4
5.50	5.25	46	2	2
Aging of Eggs				
0.50	0	41	36	34
30.00	0	75	39	39
60.00	0	31	22	22
120.00	0	26	54	50
180.00	0	26	42	42

*The temperature at time of fertilization was 24.4° C.(76.0° F.). During the entire experiment, 118 hours, the temperature ranged from 23.0° to 27.2° C.(73.5° to 81.0° F.) and averaged 25.1° C.(77.2° F.).
†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A13.—Experiment G4: duration of fertility of activated eggs from a single female green sunfish. Sperm used in this experiment were from a single male.*

Age of Eggs in Minutes	Age of Sperm in Minutes	Number of Eggs	Percent of Eggs that Hatched	Percent of Eggs that Developed into Fry†
Aging of Eggs				
0.50	0	36	75	75
30.00	0	51	53	53
60.00	0	33	48	48
120.00	0	31	26	26
180.00	0	48	10	8

*The temperature at time of fertilization was 26.9° C.(80.5° F.). During the entire experiment, 101 hours, the temperature ranged from 26.1° to 28.3° C.(79.0° to 83.0° F.) and averaged 27.3° C.(81.1° F.).
†Fry able to swim for short periods but not completely free swimming. Only normal fry are included in this figure.

Table A14.—Experiment S1: some aspects of the development of red-ear sunfish zygotes and hybrid zygotes during the first 161 hours of their development. Throughout the experiment hourly temperatures averaged 23.6° C. (84.5° F.), standard deviation 0.77° C. (1.38° F.).

Parents ^a	Sample Number	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry		Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Number Measured	Standard Deviation
♂ x ♀	R x R	1	41	52.1	4.22			24			
	2	39	46	49.3	5.29			46			
	3	55	53	50.1	5.67			44			
	Combined samples	135	45	50.3	5.36	23.8	0.41	38		25	0.300
B x R	1	50	46	52.8	4.38			36			
	2	53	55	49.9	5.15			47			
	3	44	75	53.5	2.77			68			
	Combined samples	147	58	52.1	4.45	23.8	0.40	50		25	0.139
G x R	1	31	29	52.1	4.50			29			
	2	43	70	49.9	5.26			56			
	3	43	65	48.4	5.34			60			
	Combined samples	117	57	49.6	5.33	23.8	0.41	50		25	0.165
W x R	1	45	13	48.8	4.78			0			
	2	42	45	48.2	2.68			0			
	3	36	56	50.2	5.25			0			
	Combined samples	123	36§	49.1	4.38	23.8	0.41	0		0	

^aR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

†Percentage based on eggs in each sample at the time sperm and eggs were mixed.

‡Incubation temperature from time of fertilization to mean time of hatching.

§More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.

Table A15.—Experiment S 2: some aspects of the development of red-ear sunfish zygotes and hybrid zygotes during the first 120 hours of their development. Throughout the experiment hourly temperatures averaged 28.7° C. (83.6° F.), standard deviation 0.44° C. (0.79° F.).

Parents ^a	Sample Number	Number of Eggs	Percent [†] Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C. [‡]		Percent Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀										
R x R	1	73	29	26.6	1.58			20		
	2	59	34	27.4	2.53			20		
	3	102	36	26.2	1.58			25		
Combined samples				26.6	1.94	28.5	0.29	23	25	0.155
B x R	1	81	23	29.1	2.08			20		
	2	93	25	27.8	1.22			19		
	3	40	55	28.4	1.82			48		
Combined samples				28.4	1.80	28.6	0.31	25	25	0.192
G x R	1	89	42	27.2	2.25			32		
	2	91	35	28.3	2.35			23		
	3	51	37	27.6	2.14			24		
Combined samples				27.7	2.31	28.6	0.31	27	25	0.189
W x R	1	73	38	28.4	3.03			5		
	2	42	19	28.0	2.29			2		
	3	69	40	27.2	2.15			6		
Combined samples				27.9	2.65	28.6	0.31	5 ^{••}	0	...

^aR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.

[‡]Incubation temperature from time of fertilization to mean time of hatching.

[§]More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.

^{••}Appeared morphologically normal, but all were behaviorally abnormal.

Table A16.—Experiment S 3: some aspects of the development of red-ear sunfish zygotes and hybrid zygotes during the first 120 hours of their development. Throughout the experiment hourly temperatures averaged 28.7° C. (83.6° F.), standard deviation 0.44° C. (0.79° F.).

Parents ^a	Sample Number	Number of Eggs	Percent [†] Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C. ‡		Percent [†] Normal Fry	Length of Fry in mm		
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Mean	Standard Deviation
♂ x ♀											
R x R	1	32	66	28.4	2.14			41			
	2	59	39	27.7	2.14			22			
	3	52	36	28.3	2.18			15			
Combined samples		143	44	28.1	2.18	28.6	0.31	24	25	5.28	0.166
B x R	1	57	30	27.6	1.21			23			
	2	44	41	27.8	2.02			32			
	3	50	54	28.8	1.73			34			
Combined samples		151	41	28.2	1.79	28.6	0.31	29	25	5.58	0.137
G x R	1	76	43	28.6	2.04			37			
	2	67	42	27.9	2.00			33			
	3	61	64	28.2	1.74			56			
Combined samples		204	49	28.2	1.94	28.6	0.31	41	25	5.54	0.185
W x R	1	145	19	25.7	2.38			3			
	2	61	26	26.2	2.57			0			
	3	35	66	27.6	2.70			0			
Combined samples		241	27§	26.5	2.67	28.5	0.27	2**	0	...	...

^aR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.
[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.
[‡]Incubation temperature from time of fertilization to mean time of hatching.
[§]More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.
^{**}Appeared morphologically normal, but all were behaviorally abnormal.

Table A17.—Experiment S 4: some aspects of the development of bluegill zygotes and hybrid zygotes during the first 184 hours of their development. Throughout the experiment hourly temperatures averaged 22.6° C. (72.7° F.), standard deviation 0.68° C. (1.22° F.).

Parents ^a	Sample Number	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀										
B x B	1	75	77	69.3	4.44			8		
	2	94	90	71.8	2.87			63		
	3	92	92	71.7	2.20			89		
	Combined samples	261	87	71.1	3.32	22.3	0.24	56	25	0.172
R x B	1	78	81	66.9	3.47			77		
	2	174	76	68.3	2.44			68		
	3	111	88	67.9	2.62			88		
	Combined samples	363	81	67.9	2.80	22.3	0.24	76	25	0.108
G x B	1	48	77	74.8	4.37			71		
	2	144	80	72.7	4.51			6		
	3	79	90	73.9	5.18			87		
	Combined samples	271	82	73.4	4.78	22.3	0.23	41	25	0.144
W x B	1	68	24	59.6	5.23			0		
	2	108	16	59.4	3.92			0		
	3	126	25	60.1	3.33			0		
	Combined samples	302	25§	59.8	4.04	22.3	0.23	0	0	...

^aR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.

[‡]Incubation temperature from time of fertilization to mean time of hatching.

[§]More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.

Table A18.—Experiment S 5: some aspects of the development of bluegill zygotes and hybrid zygotes during the first 113 hours of their development. Throughout the experiment hourly temperatures averaged 26.9° C. (80.4° F.), standard deviation 0.48° C. (0.86° F.).

Parents ^o	Sample Number	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀										
B x B	1	53	79	33.7	1.29			79		
	2	131	86	34.2	2.20			85		
	3	73	85	33.4	2.11			82		
Combined samples		257	84	33.9	2.06	26.8	0.37	83	25	4.98 0.110
R x B	1	77	91	34.3	1.75			90		
	2	66	94	34.8	1.69			92		
	3	52	98	34.9	1.37			98		
Combined samples		195	94	34.6	1.66	26.8	0.37	93	25	4.98 0.151
G x B	1	73	88	32.8	1.59			78		
	2	88	93	34.4	2.09			93		
	3	58	95	35.7	1.64			93		
Combined samples		219	92	34.3	2.14	26.8	0.37	88	25	5.00 0.164
W x B	1	86	86	29.3	1.81			0		
	2	76	92	29.6	1.20			0		
	3	52	94	29.0	1.23			0		
Combined samples		214	90§	29.4	1.49	26.8	0.40	0	0	...

^oR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

†Percentage based on eggs in each sample at the time sperm and eggs were mixed.

‡Incubation temperature from time of fertilization to mean time of hatching.

§More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.

Table A19.—Experiment S 6: some aspects of the development of bluegill zygotes and hybrid zygotes during the first 105 hours of their development. Throughout the experiment hourly temperatures averaged 27.3° C. (81.1° F.), standard deviation 0.65° C. (1.17° F.).

Parents ^o	Sample Number	Number of Eggs	Percent [†] Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C. [‡]		Percent [†] Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀										
B x B	1	21	71	32.3	0.54			71		
	2	91	91	32.4	0.82			91		
	3	51	96	32.9	0.85			96		
Combined samples		163	90	32.5	0.83	27.0	0.42	90	25	0.076
R x B	1	65	83	31.8	0.81			78		
	2	41	90	31.6	1.06			90		
	3	78	90	31.9	0.68			87		
Combined samples		184	88	31.8	0.83	27.0	0.40	85	25	0.069
G x B	1	43	88	32.4	0.92			88		
	2	44	93	32.4	0.96			93		
	3	62	90	32.2	1.09			90		
Combined samples		149	91	32.3	1.01	27.0	0.40	91	25	0.095
W x B	1	49	98	27.6	1.49			8		
	2	57	88	28.3	1.77			2		
	3	77	95	27.8	1.89			1		
Combined samples		183	93 [§]	27.9	1.77	26.8	0.28	3 ^{§§}	0	...

^oR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.

[‡]Incubation temperature from time of fertilization to mean time of hatching.

[§]More than 90 percent of these larvae were morphologically abnormal and all were behaviorally abnormal.

^{§§}Appeared morphologically normal, but all were behaviorally abnormal.

Table A20.—Experiment S 7: some aspects of the development of green sunfish, zygotes and hybrid zygotes during the first 151 hours of their development. Throughout the experiment hourly temperatures averaged 24.4° C. (75.9° F.), standard deviation 0.46° C. (0.83° F.).

Parents ^o	Sample Number	Number of Eggs	Percent [†] Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C. [‡]		Percent [†] Normal Fry	Length of Fry in mm		
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Mean	Standard Deviation
♂ x ♀											
G x G	1	49	71	50.4	2.42			69			
	2	43	74	50.8	1.60			74			
	3	64	80	49.2	2.53			76			
Combined samples		156	76	50.0	2.37	23.8	0.27	74	25	4.79	0.095
R x G	1	41	85	48.4	1.17			85			
	2	45	89	47.7	1.71			89			
	3	48	83	48.0	1.84			83			
Combined samples		134	86	48.0	1.64	23.8	0.26	86	25	4.62	0.097
B x G	1	38	50	51.4	2.71			50			
	2	66	83	49.8	2.19			77			
	3	78	77	48.6	3.00			76			
Combined samples		182	74	49.5	2.52	23.8	0.27	71	25	4.74	0.079
W x G	1	34	76	48.9	2.10			0			
	2	48	83	48.9	2.95			79			
	3	70	87	48.4	2.61			78			
Combined samples		152	84	48.7	2.64	23.8	0.27	61	25	4.60	0.132

^oR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.

[‡]Incubation temperature from time of fertilization to mean time of hatching.

Table A21.—Experiment S 8: some aspects of the development of green sunfish zygotes and hybrid zygotes during the first 104 hours of their development. Throughout the experiment hourly temperatures averaged 27.3° C. (81.1° F.), standard deviation 0.66° C. (1.18° F.).

Parents ^a	Sample Number	Number of Eggs	Percent [†] Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.‡		Percent [†] Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀										
G x G	1	101	65	31.1	2.14			63		
	2	87	83	32.8	1.31			79		
	3	118	81	30.7	2.05			80		
Combined samples		306	76	31.5	2.08	27.1	0.44	74	25	0.237
R x G	1	40	65	32.5	0.88			60		
	2	52	92	31.7	0.85			88		
	3	114	82	31.4	0.88			81		
Combined samples		206	81	31.7	0.95	27.1	0.44	79	25	0.091
B x G	1	64	56	30.8	1.20			56		
	2	68	84	31.8	1.08			84		
	3	60	83	31.5	1.14			82		
Combined samples		192	74	31.4	1.20	27.0	0.42	74	25	0.118
W x G	1	53	62	29.0	1.83			26		
	2	90	86	30.0	1.88			59		
	3	71	89	30.0	2.02			55		
Combined samples		214	81	29.8	1.96	27.0	0.41	50	25	0.098

^aR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.

[‡]Incubation temperature from time of fertilization to mean time of hatching.

Table A22.—Experiment S 9: some aspects of the development of green sunfish zygotes and hybrid zygotes during the first 78 hours of their development. Throughout the experiment hourly temperatures averaged 28.1°C. (82.5°F.), standard deviation 0.51°C. (0.92°F.).

Parents*	Sample Number	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry		Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Number Measured	Standard Deviation
♂ x ♀											
G x G	1	39	74	29.0	1.71			67			
	2	94	86	28.8	1.56			81			
	3	44	82	29.8	1.97			82			
Combined samples		177	82	29.1	1.75	27.6	0.32	78		25	0.187
R x G	1	109	77	26.7	1.13			75			
	2	96	79	27.4	1.32			79			
	3	52	75	28.9	0.87			75			
Combined samples		257	77	27.4	1.45	27.6	0.31	77		25	0.201
B x G	1	66	71	28.4	1.05			65			
	2	102	74	28.2	1.75			68			
	3	47	68	27.1	1.38			62			
Combined samples		215	72	28.0	1.57	27.6	0.31	66		25	0.204
W x G	1	138	64	28.4	1.41			54			
	2	83	77	29.6	1.58			60			
	3	91	66	29.1	1.02			58			
Combined samples		312	68	29.0	1.46	27.6	0.32	57		25	0.182

*R = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

†Percentage based on eggs in each sample at the time sperm and eggs were mixed.

‡Incubation temperature from time of fertilization to mean time of hatching.

Table A23.—Experiment S 10: some aspects of the development of warmouth zygotes and hybrid zygotes during the first 115 hours of their development. Throughout the experiment hourly temperatures averaged 27.2° C. (81.0° F.), standard deviation 0.45° C. (0.81° F.).

Parents ^a	Sample Number	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀	W x W	89	48	28.8	1.60			44		
	2	50	56	30.1	1.11			46		
	3	40	52	29.6	1.46			48		
Combined samples		179	51	29.4	1.55	27.3	0.33	45	25	0.176
R x W	1	49	39	29.8	1.03			37		
	2	81	53	29.0	1.26			48		
	3	45	44	29.8	1.41			42		
Combined samples		175	47	29.4	1.31	27.3	0.33	43	25	0.139
B x W	1	72	54	30.5	1.24			42		
	2	60	52	31.2	1.36			45		
	3	65	54	30.7	1.21			48		
Combined samples		197	53	30.8	1.29	27.3	0.33	45	25	0.180
G x W	1	57	51	30.4	1.66			44		
	2	44	54	31.0	1.26			50		
	3	45	60	31.3	0.92			9		
Combined samples		146	55	30.9	1.37	27.3	0.33	35	25	0.212

^aR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.[†]Percentage based on eggs in each sample at the time sperm and eggs were mixed.[‡]Incubation temperature from time of fertilization to mean time of hatching.

Table A24.—Experiment S11: some aspects of the development of warmouth zygotes and hybrid zygotes during the first 78 hours of their development. Throughout the experiment hourly temperatures averaged $28.1^{\circ}\text{C.}(82.5^{\circ}\text{F.})$, standard deviation $0.51^{\circ}\text{C.}(0.92^{\circ}\text{F.})$.

Parents ^o	Sample Number	Number of Eggs	Percent Hatched	Hatching Time in Hours		Incubation Temperature in Degrees C.†		Percent Normal Fry	Length of Fry in mm	
				Mean	Standard Deviation	Mean	Standard Deviation		Number Measured	Standard Deviation
♂ x ♀										
W x W	1	48	75	28.4	1.56			62		
	2	38	55	28.9	1.62			45		
	3	30	77	29.6	1.17			60		
Combined samples		116	69	28.9	1.56	27.6	0.31	56	25	0.204
R x W	1	59	83	29.1	0.63			73		
	2	30	77	29.6	0.90			70		
	3	55	79	29.0	1.37			62		
Combined samples		142	80	29.2	1.03	27.6	0.31	68	25	0.199
B x W	1	26	73	28.9	1.09			62		
	2	33	61	29.0	1.53			48		
	3	55	69	28.9	1.14			53		
Combined samples		114	68	28.9	1.24	27.6	0.31	54	25	0.141
G x W	1	33	67	29.6	1.12			52		
	2	37	59	29.8	0.91			51		
	3	60	80	29.7	0.98			73		
Combined samples		130	71	29.7	1.00	27.6	0.32	62	25	0.203

^oR = red-ear sunfish, B = bluegill, G = green sunfish, and W = warmouth.

†Percentage based on eggs in each sample at the time sperm and eggs were mixed.

‡Incubation temperature from time of fertilization to mean time of hatching.

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ILLINOIS NATURAL HISTORY SURVEY

Bulletin

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The Thrips, or Thysanoptera, of Illinois

LEWIS J. STANNARD

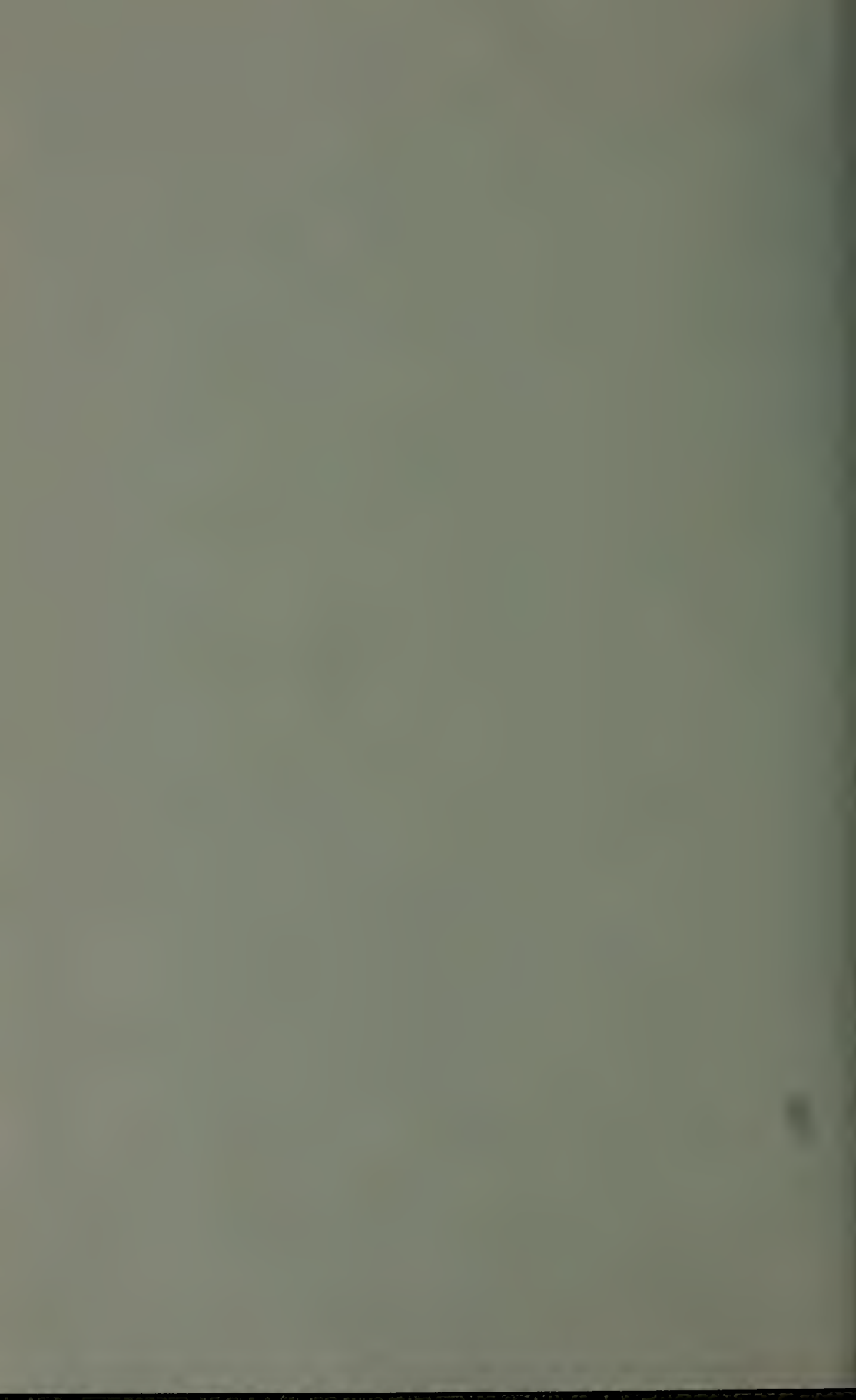
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DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION
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ILLINOIS NATURAL HISTORY SURVEY

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the State of Illinois



Volume 29, Article 4
May, 1968

The Thrips, or Thysanoptera, of Illinois

LEWIS J. STANNARD

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION

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FOREWORD

THE Illinois Natural History Survey's interest in thrips dates back many years. In 1908 J. D. Hood, then a part-time employee of the Survey, described several new species. Little attention was given to the order in Illinois for the next two decades.

In the early 1930's the unconnected activities of two entomologists who never worked seriously on thrips led to a rejuvenation of the Survey's interest in this order. Survey entomologist M. D. Farrar began using berlese funnels to investigate chinch bug hibernation habits. His duff samples from forest floor stations netted large numbers and a considerable variety of thrips. At about the same time Orlando Park, then at the University of Illinois and a specialist in beetles of the family Pselaphidae, enlisted the aid of the Survey's Faunistic Section in processing berlese samples from different areas in Illinois in order to obtain pselaphid beetles. Again large numbers of thrips were encountered. Because the Survey collection of thrips was virtually nonexistent, the thrips material was segregated and stored, pending an opportunity to study the group in greater detail.

By that time it had become obvious that there were no adequate keys to identify midwestern thrips, that the thrips had large numbers of diagnostic characters that had never been illustrated, and that our knowledge of the geological distribution, food preferences, and ecological relationships of the thrips were but scantily known for North America.

In the early 1950's Dr. L. J. Stannard began a project aimed at producing a comprehensive treatment of the order for Illinois. With intensive collecting, species after species was added to the list. In order to under-

stand the distribution patterns, collecting was extended into surrounding states and finally a scattering of collections was obtained for the entire eastern half of the continent. Following the tradition of ecological orientation tracing back to early Survey publications of a century ago, information was gathered on the seasonal distribution of the various species of thrips and on their food relationships. Thanks to the unstinting cooperation of Survey botanist R. A. Evers, accurate host data were established for the phytophagous species.

As the research progressed, so did the difficulties. The introduction of phase microscopy demanded water-based mounting media, such as Hoyer's, but the arid indoor conditions during the Illinois winters presented an almost unsurmountable problem of slide maintenance. This problem has still to be solved satisfactorily.

The greatest problems were those concerning the delineation and naming of genera. With assistance from the Guggenheim Foundation and the National Science Foundation, Dr. Stannard was able to study genotypes of practically all the world genera of thrips, and only after this comprehensive review was a relatively stable generic classification possible. It is remarkable that such small insects as thrips raise so many large problems.

We take great pleasure in presenting this account of the thrips of Illinois as one of the Survey's series of faunistic accounts of the animal groups of the State.

HERBERT H. ROSS
*Assistant Chief and
Head of Section of Faunistic
Surveys and Insect Identification*

This report is dedicated to Professor Doctor Hermann Priesner of Linz, Austria, master of the Thysanoptera, in commemoration of his seventy-fifth birthday. His thoughtful and numerous contributions to the systematics of thrips over more than a half-century have given stability and lasting good leadership to our science.

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The Thrips, or Thysanoptera, of Illinois

Lewis J. Stannard

THRIPS ARE COMMONPLACE in Illinois. A few kinds are notorious as a scourge to onion farmers and gladiolus growers, and to picnickers in midsummer, when in certain years the oats thrips swarm in such high numbers that they can be noticed from a distance as clouds. Thrips are in almost every flower, in vagrant daisies and dandelions, in the finest peonies and roses, in prairie legumes and composites, and even in Indian Pipes. Thrips are under sheaths of corn, under bark, in leaf mold, and oddly enough on water lily pads and skunk cabbage. So common are they that nearly everyone is aware of them.

It is by their abundance and not by their lilliputian appearance, however, that thrips are so generally known. Thrips as a whole, the order Thysanoptera, are the smallest of the pterygote insects. In Illinois the largest thrips measures at the most 5 mm, the smallest 0.6 mm, and the average is only 1.5 mm. More than likely thrips are popularly perceived as mere black specks, or only their damage is noticed. The detailed nature of the thrips is the special province of but a few entomologists and naturalists.

This report* is presented to make our tiny thrips better known—to show what thrips really are, to explain which ones are harmful and which ones are beneficial, and to introduce the many thrips that are of no direct economic consequence to man but are a part of the native fauna of Illinois. As will be shown, thrips are exquisite creatures, complicated in form, delicate in habit, and most dis-

tinct from the usual run of insects. About 200 species of thrips have been collected in Illinois. Herein is an account of those species and of some others that may occur, but so far have not been found, in our state.

ACKNOWLEDGMENTS

The background preparations for this report began so long ago (just before the 1950's) that I have forgotten in some cases which person gave me a precise idea, or brought to my attention certain correlations or modes in the faunal composition of various sections of Illinois and adjacent states. I am indebted to all who have aided in this work, even though proper thanks no longer can be given to some individuals due to the passage of time and my imperfect memory.

Specifically, I wish to thank my colleagues, peers, and superiors of the Illinois Natural History Survey for helping me collect the specimens which document this report. In particular I am indebted to Drs. W. S. Brooks, B. D. Burks, H. B. Cunningham, G. C. Decker, R. J. Dysart, J. M. Kingsolver, J. A. Lowe, W. H. Luckmann, H. B. Mills, C. O. Mohr, W. C. Moye, T. E. Moore, W. R. Richards, H. H. Ross, M. W. Sanderson, P. W. Smith, and J. D. Unzicker; Messers J. S. Ayars, M. E. Braasch, J. D. Felix-Williams, Dannel McCollum, E. O. Moll, G. L. Nordin, S. J. Roberts, G. L. Rotramel, and J. T. Shaw; Mrs. Leonora Gloyd; and many others whose names appear on the data given for the species preserved in our permanent collection.

Further I am most obliged to Mesdames Marie Fischer and Charlene Koeling; Drs. W. S. Brooks, H. B. Cunningham, and T. E. Moore; and Messers R. G. Altig, T. G. Brooks,

*Reference to the literature was concluded, for the most part, early in 1965 when this report was essentially completed. One of the few references subsequently added, Mound's proposals to the International Commission of Zoological Nomenclature (1966), was included because of the important name changes involving *Phlaeothrips* and *Hoplothrips*.

FRONTISPIECE. *Anaphothrips sandersoni* against the background of its host, *Spartina pectinata*. Designed by R. M. Sheets.

W. C. Faatz, E. O. Moll, and G. L. Nordin for their excellent slide preparations and for many favors.

I shall always be grateful to my fellow thysanopterists, who have counseled me, continually supplied me with specimens and notes from their collections, and told me of their experiences and postulations. Prof. Dr. Hermann Priesner of Linz, Austria, Miss Kellie O'Neill of Washington, D.C., and the late Mr. Dudley Moulton of San Gabriel, California, were the three with whom I had the most communication and to whom my obligations are particularly great.

The conclusions in this report are based not only on the Illinois fauna, but to the extent possible on the total world fauna. In the course of my studies, I received travel grants from the John Simon Guggenheim Memorial Foundation, the National Science Foundation, and Sigma Xi to consult the majority of the world's collections of Thysanoptera. I wish to acknowledge my appreciation to these organizations for their aid, as well as to the curators of the collections consulted, namely: American Museum of Natural History, Bernice P. Bishop Museum, British Museum (Natural History), California Academy of Sciences, Canadian National Museum, Field Museum of Natural History, University of Florida (Experiment Station Collection), University of Kansas (Snow Collection), Philadelphia Academy of Natural Sciences, and U.S. National Museum. The private collections of Dean Floyd Andre and Dr. R. L. Post in the United States of America, Prof. Dr. Hermann Priesner in Austria, and Dr. C. B. Williams in England were also kindly made available to me, for which I am most obliged.

Many foreign and exotic collections were donated to our reference collection by Drs. J. T. Allen, E. C. Becker, Federico Bonet, W. L. Brown, Jr., G. C. Decker, Jean and R. R. Graber, G. E. Haas, R. L. Hass, H. C. Hanson, G. C. Hoff, Makram Kaiser, G. F. Knowlton, W. L. N. Krauss, H. B. Mills, E. L. Mockford, H. H. Ross, G. C. Sanderson, M. W. Sanderson,

R. B. Selander, P. W. Smith, K. M. Sommerman, and R. W. Strandtmann; and Messers J. S. Ayars, and Fritz Plaumann, as well as other members of our Survey and cooperating institutions. Material from thysanopterists in Africa, Europe, Asia, and North and South America has been deposited with us. For all of these contributions I am extremely grateful.

Mrs. A. A. Prickett executed many of the pen-and-ink drawings, Mrs. Diana Slavens drew the *Anaphothrips sandersoni* for the frontispiece and several other figures, Mr. W. D. Zehr was responsible for most of the photographs, Messers R. W. Rehling, R. M. Sheets, and W. L. Taylor prepared other illustrative material, Mr. O. F. Glissendorf edited the manuscript, Mesdames Bernice Sweeney and Bess White and Miss Sandra Krencius typed the manuscript and preliminary drafts, and Mr. G. L. Nordin helped prepare the bibliography. Especially to these persons from our Survey, I wish to express my fullest appreciation.

Finally, over and above other acknowledgments, to Dr. H. H. Ross, my immediate superior, and to Drs. R. A. Evers, M. W. Sanderson, and P. W. Smith, my colleagues, I submit my unqualified gratitude for their direct aid, perpetual encouragement, and infectious enthusiasm, and for their willingness to share with me their extensive knowledge of the biota of Illinois.

NATURAL HISTORY

Feeding

In an American textbook, wherein insects are arranged according to their type of feeding habits, the Thysanoptera are placed alone in the rasping-sucking division (Metcalf & Flint, revised by Metcalf 1962). Almost certainly the rasping-sucking designation is inappropriate, but even so the feeding method of the Thysanoptera is unique.

The precise manner in which thrips feed is still not known. It is recorded in the literature (Reyne 1921) that in

one species of Terebrantia, the single mandible is driven through the surface of the leaf, by a woodpecker-like movement of the head. Thereafter, it is presumed, the maxillary stylets are introduced into the hole thus made in the leaf epidermis, and by asynchronous movements of these stylets the underlying leaf cells are punctured. Fluid from the ruptured cells probably oozes to the outside where it is sucked into the appressed mouth cone of the thrips. Rasping or scraping of outer leaf surface probably does not occur.

Observations of pollen feeding by nine species of flower thrips, representing the families Aeolothripidae, Thripidae, and Phlaeothripidae, was made by Grinfel'd (1959). He reported that the thrips grasps grains of pollen by the fore legs, securing hold by means of protuberances on the anterior tibiae. After each grain is brought by the legs to the mouth cone, the labial and maxillary palps serve to hold and carry it. Upon feeding the thrips presses the pollen grain against the substrate and thrusts the single mandible into it. Later, possibly either the oozing liquid is sucked directly from the puncture or the maxillary stylets are inserted to help somehow in imbibing the liquid. Grinfel'd noted that feeding may take place 2-20 seconds for each pollen grain, subject to the size of the grain, the species of thrips, and the air temperature. Both larvae and adults of these flower thrips feed on pollen grains. In other instances Grinfel'd has seen thrips drink nectar from flowers.

An unusual type of feeding was observed by Downey (1965). Species of *Taeniothrips*, examined under a binocular microscope, were seen to imbibe secretions of the abdominal exudate glands of mature larvae and one pupa of lycaenid butterflies. Ordinarily these glands do not secrete unless stimulated by the caressing touches of ants. Seemingly the thrips were able to provide proper incitement to the butterfly larvae to cause the glands to exude liquid.

Some thrips are well known predators or are on occasions predators (Bailey 1951, and Ebeling 1950). In

fact several species will bite man and cause a minor itching sensation (Bailey 1936). Frequently, in the Tubulifera, many members of which have long, flexible maxillary stylets, the food seems to be fungi and other substances rather than flower pollens or plant juices, according to our collection data. I have found in the gut of an *Oedaleothrips* a concentration of Phaeophragmiae-type spores which were dark colored, cross septate, and four celled. Each was approximately $6 \times 20 \mu$ in size. Possibly such small fungus spores are commonly ingested by the Megathripinae, at least.

Movements to feeding spots, as well as other activities, may be governed by the relative humidity and adjustment of thrips to body water balance. Cederholm (1963) has secured correlations of the diurnal movement of certain species of thrips with humidity and cloud cover in Sweden.

Larvae and adults rid the body of excess water and waste through the anus. In some larval thrips the excreted liquid is held as a droplet between the anal hairs. When the droplet reaches a specific size, it is deposited on a leaf surface. Dark-colored spots of excretia near light-colored feeding zones are characteristic signs of larval and adult thrips damage. No feeding occurs in the pupal stages.

Senses

Despite long, historic, employment of sensory organs as taxonomic characteristics, the extent and the true nature of the senses of thrips are not well known.

The antenna usually contains thin-walled circular or conical sensoria on segments III-VI. Another circular sensorium occurs on the dorsal surface of antennal segment II and what seems to be a Johnson's organ lies within the apical pit of antennal segment II. Presumably these antennal sense organs are chemoreceptors. I have observed species of Terebrantia flick their antennae back and forth towards the substrate much in the manner of ichneumonid wasps, supposedly to test the environment by

bringing the sensoria close to objects. Sensorial pores also may be found at the bases of the femora.

Often males and occasionally females exhibit abdominal sternal gland-like areas of unknown function.

According to Carthy (1958), a species of *Thrips* seems to have no color vision. On the other hand Wilde (1962) presented data which indicate that some Thysanoptera (*Taeniothrips* sp.) prefer white to yellow. *Gynaikothrips ficorum* is attracted to yellow and orange, much to the annoyance of visitors to Hawaii who often wear gaily-colored sport shirts (J. W. Beardsley, University of Hawaii, personal communication, 1964).

Tactile Setae and Spurs

Tactile setae are common and are frequently so stable in their position and form that even generic limits and key characteristics are based upon them. Many are expanded at the tips (Fig. 1 and 2).

Cocoon-breaking hooks are present on adults of several families, and presumably they aid in freeing the emerging imago.

Some leg setae are used for grooming. I have often observed *Frankliniella tritici* brush the wings with the heavy bristles that line the inside of the hind tibiae. These movements apparently comb and straighten the fringe cilia of the wings when the wings are in place over the abdomen. Bristles on the fore legs play a part in the brushing and grooming of the an-

tennae. The mid legs are also used for cleaning, to groom the hind legs especially. Once while watching a brachypterous female of *Frankliniella fusca*, I observed the thorough brushing of the abdomen by the hind legs. In the process this female bent the abdomen upwards and then sideways so she could reach the terminal parts of the abdomen with the hind tarsi. Frequently pairs of legs are rubbed together. Watson (1920) in his article on the toilet of thrips stated that grooming was a major preoccupation of thrips.

Other setae and spurs may be employed for holding the partners during mating. In the Tubulifera abdominal wing-holding setae (Fig. 1) engage the fringe cilia of the wings when in repose.

Sound Production

Some Thysanoptera may produce sound. Hood (1950b) and Faure (1955) described the stridulatory apparatus of certain Tubulifera to be the ridges on the fore coxa and the prolongations of the inner apex of the fore femur. Presumably when these surfaces are rubbed together tonal vibrations are made. Zur Strassen (1959a) illustrated a possible stridulatory organ in the Terebrantia, located on abdominal tergite IV in the African *Frankliniella megalops*.

Reproduction

It is generally presumed that reproduction in the Thysanoptera is primarily by bisexual union (Bailey 1933, and Pesson in Grassé 1951). Collectors of thrips have observed, however, that females are the commonest sex found, and, in fact, males of many species are rare or still unknown.

The apparent paucity of males has led to the belief that parthenogenetic reproduction is also frequent. Actually thelytoky parthenogenesis (virgin females producing only female offspring) has been demonstrated in the laboratory for several species including the grass thrips *Anaphothrips obscurus* (= *striatus*) (Shull 1914). This type of parthenogenesis seems to be common



Fig. 1-2.—Types of setae: 1, wing-holding seta of *Neurothrips magnafemoralis*; 2, body seta with expanded tip of *Hydiiothrips atomarius*.

in introduced species of thrips. Further Shull (1917) showed that in *Haplothrips verbasci* virgin females could produce eggs that resulted in males only (arrhenotoky parthenogenesis). Still other species are purported to be cyclic in that, because of temperature, production of males may be suppressed during particular seasons (Jordan 1888). As pointed out by Bournier (1956a), certain species which have but a single generation may have short-lived males. In these cases, females, possessing a longer life span, are apt to be noted by the collector more frequently than males. Thus a false impression as to the likelihood of parthenogenetic reproduction might be formed.

Apparently females are always diploid and males are haploid in the Thysanoptera (Whiting 1945). Hood's statement (1954b) to the contrary was unsupported by published evidence, if any evidence existed at all.

In mating (Fig. 3), the male grasps the female around the pterothorax, attains a superior position, then twists the abdomen underneath for copulation (Buffa 1907). Appendages and certain setae may be engaged to help hold the mating couples in position. Males may successively mate with several females. An unusual type of

mating is reported for the species *Limothrips denticornis*. In this species the male does not mate with the adult female, but instead effectively inseminates the female pupa (Bournier 1956a). By contrast, Davies (1961) did not find evidence of such precocial mating in *L. cerealium*.

Franssen & Mantel (1964) illustrate preserved, slide-mounted Terebrantia in copulation and summarize information on the reproductive organs of the Thysanoptera.

Sperm is stored in the female in the spermatheca. Overwintering females of some species retain the spermatozoa within the spermatheca to fertilize eggs laid next spring.

The Terebrantia, and ordinarily the Tubulifera, lay eggs. Many females of the Terebrantia split plant epidermis by means of their saw and deposit each egg in the tissues. On the other hand, females of the terebrantian *Chirothrips obesus* deposit eggs on the surfaces of leaves (Pesson, *in* Grassé 1951). In the Tubulifera, females of which lack saws, eggs are secured to plant surfaces by gelatinous materials, or laid in cracks and crevices or in galleries in wood formed by other insects. In the Megathripinae, several cases of ovoviviparity have been observed, where eggs are retained in the body of

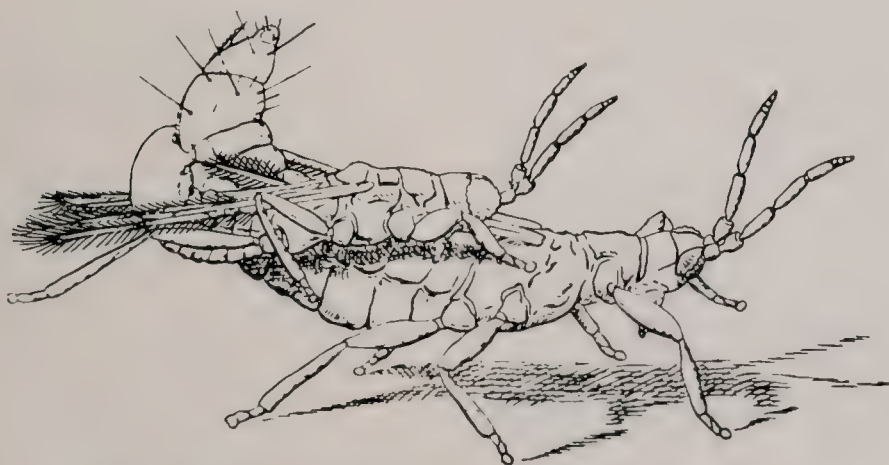


Fig. 3.—*Aeolothrips fasciatus*, ♂ and ♀ in copulation. From Melis (1959).



Fig. 4.—Eggs of *Scirtothrips citri* in tissues of orange leaf (from U.S. Department of Agriculture, Circular 708, 1944).

the female until fully formed larvae have developed (Bournier 1957). Bagnall (1915a) reported a case of a thrips sitting over eggs.

Eggs of Thysanoptera are relatively large in relation to the size of the female that lays them. Terebrantian eggs (Fig. 4) are usually smooth, with a thinly developed, light-colored chorion. Eggs of the Tubulifera are often sculptured with hexagonal reticulations. Not many eggs are laid by a female in one day although it has been estimated that over the season individual females of a tubuliferon have each deposited several hundred eggs (Melis 1935).

Immature Stages

Customarily thysanopterists (Priesner 1926a, 1926b–1928, Morison 1947–1949, Speyer 1935, etc.) have called the first and second stages of the postembryonic forms of thrips *larvae* (Fig. 5, 6, 7, 9, and 10), and the remaining quiescent, nonfeeding, pre-adult instars *pupae* (Fig. 8, 11, 12, 13, and 14). These traditional terms are applied herein, irrespective of the various objections to the contrary expressed by entomologists, including some thysanopterists (Bailey 1957, Cott 1956, and others).

In the postembryonic period there are two larval stages. These larvae ingest all food necessary for development to the adult form. As in holometabolus insects the larval period is followed by the nonfeeding pupal period.

Among the Terebrantia there are one (in species of *Franklinothrips*) or more commonly two quiescent pupal stages. Pupae, if disturbed, are capable of walking. First there is a *pre-pupal* stage in which the antennae are short and positioned forward of the head, and the wing buds (when present) are moderately short and placed along the sides of the body. This is followed by the *pupal* stage (Fig. 8),

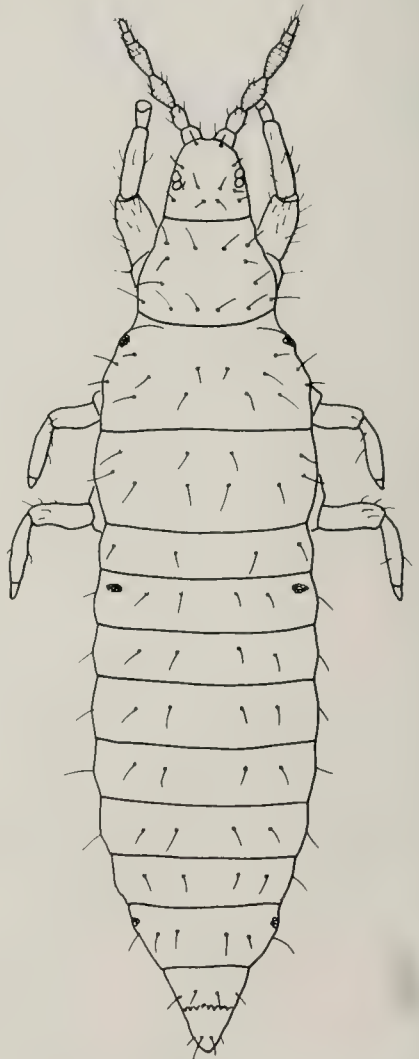
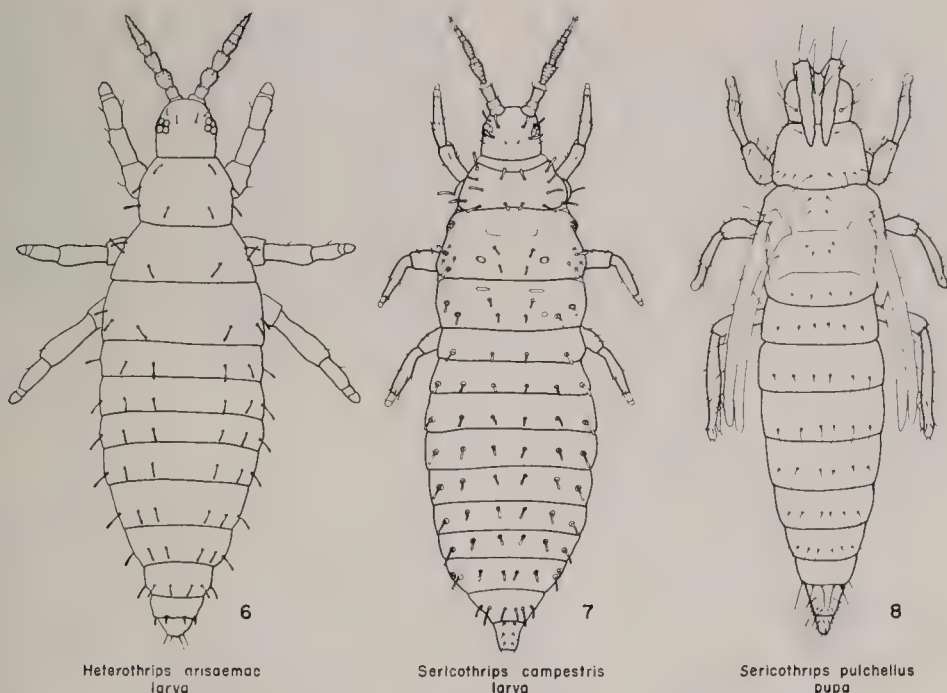


Fig. 5.—Larva of *Thrips monotropae*, showing morphological characteristics.



Heterothrips arisaemae
larva

Sericothrips campestris
larva

Sericothrips pulchellus
pupa

Fig. 6-8.—Terebrantia, immature forms of species indicated.

characterized by the antennae placed over the head dorsally and the wing buds elongated. The imago transforms from this stadium.

Among the Tubulifera there are usually three pupal stages. In the first (*primipupal*) stage, the antennae, which project laterally from the head, and the legs are shortened (Fig. 12). In the *prepupal* stage (Pupa I of some previous authors), the antennae lie along the side of the head (Fig. 13), and wing buds (if wings are to be present in the adult) lie along the side of the body. In the pupal stage (Pupa II of some previous authors) the antennae are elongated and the wing buds extend to curl slightly over the abdomen (Fig. 14).

Neither larvae nor pupae of thrips bear ocelli, as in most members of the Corrodentia-Thysanoptera-Hemiptera phyletic line (Stannard 1956a).

Pupae are often developed in cocoons (Fig. 15) spun by the second instar larvae in the Aeolothripidae and Heterothripidae, or on leaves, and

even in earthen cells, as in the case of the Thripidae.

Orbtl (1963) reports that in *Odonotothrips loti* of the Thripidae the second instar larva leaves the flowers of the host plant to migrate into the soil. Within 24 hours, while in the soil, the larva molds an earthen cell lined with silk spun from terminal abdominal glands. Inside this cell the prepupa emerges and remains in that stage for 31-39 hours. Finally the pupal stage is produced from which an adult emerges 60-69 hours later.

The special fore tarsal hooks found in the Aeolothripidae and Heterothripidae (Fig. 76 and 77) are believed to enable the newly emerged adult to break the cocoon and escape. Species of *Odonotothrips* and *Taeniothrips inconsequens* also have claws or hooks (Fig. 78) on the fore legs which may help them to break loose from their earthen, silk-lined, cells.

Pupation in the Tubulifera occurs on or near the substrate where the larva has fed.

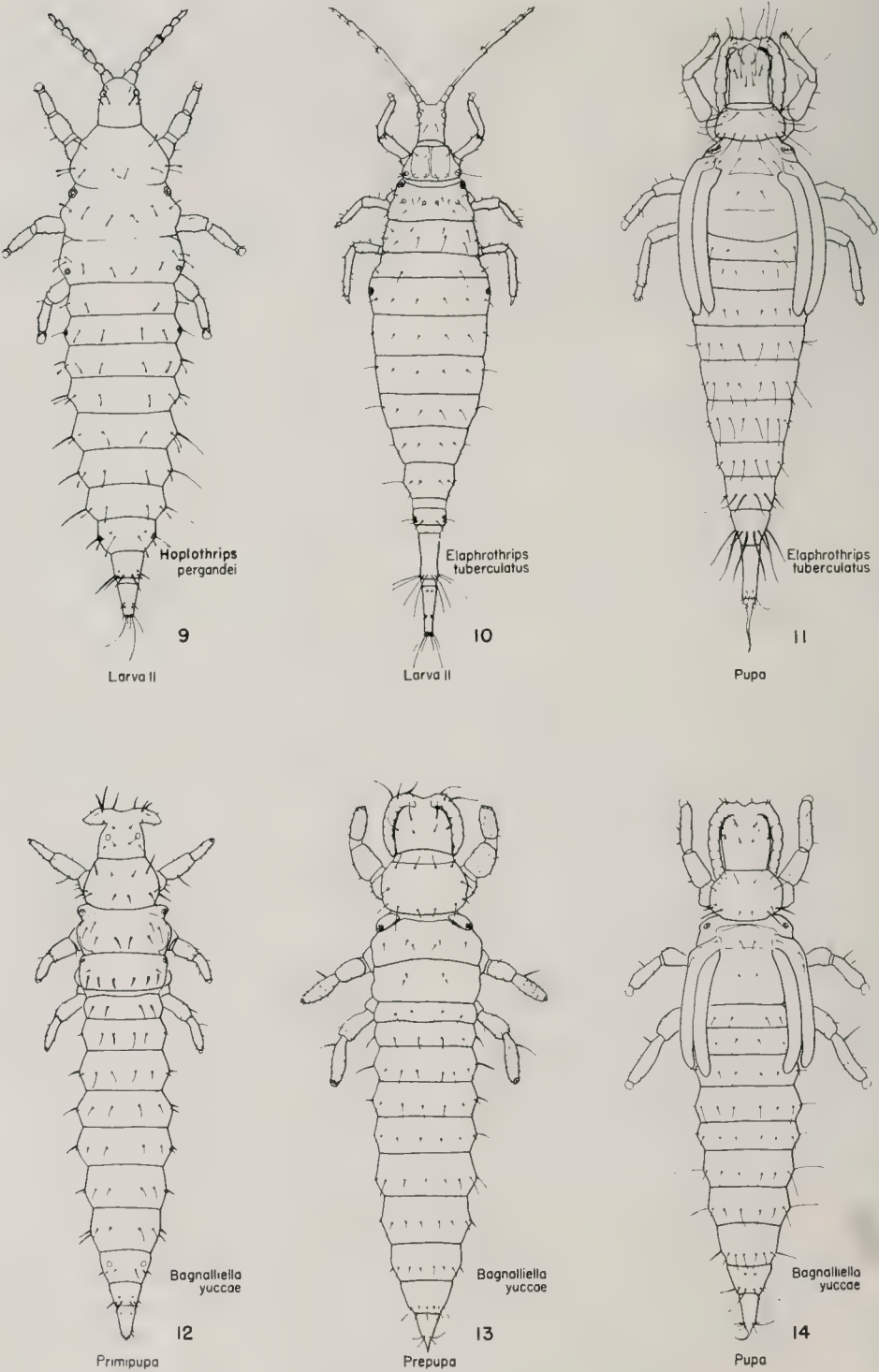


Fig. 9-14.—Tubulifera, immature forms of species indicated.

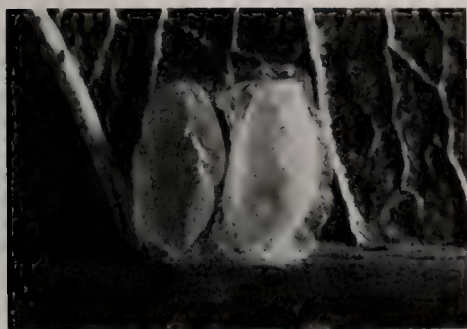


Fig. 15.—Pupal cocoons of *Frankliniopsis vespiiformis*. Photo by Walter Ebeling, University of California.

Hibernation and Aestivation

Neither the mode nor the hibernacula of overwintering Thysanoptera have been much investigated.

In general those Thysanoptera that live in leaf mold on the forest floor and those that occur regularly in summer in the accumulated debris of stools of prairie clump grasses (Fig. 36) can be found there in winter also, primarily in the adult stage. *Frankliniella tenuicornis*, an introduced European species that feeds during the summer on corn (*Zea mays*), is often collected in winter months from clump grasses.

Some of the subcortical species probably withdraw deep into cracks or crevices of bark during the cold weather, as reported by Bailey (1931) for *Poecilothrips*. Some species probably spend the winter in the earth in cells, possibly as pupae or newly formed adults, as is the case in *Taeniothrips inconsequens* (Moulton 1905). Others, such as *Elaphrothrips armatus*, hibernate in the hollow stems of dead herbs. The introduced *Bagnalliella yuccae* and *Haplothrips verbasci* usually can be found behind the appressed leaves of their respective host plants throughout the year.

Whether or not some thrips overwinter in Illinois in the egg stage is unknown. Probably the delicate eggs of Terebrantia would desiccate during the winter unless imbedded in a fleshy part of a plant not subject to hardening or drying. On the other hand, the tougher eggs of Tubulifera might survive in protected places.

Possibly some thrips populations die out during our rigorous winters, to be replaced each year by migrations from the South, as indicated in the trapping done by Henneberry, Taylor, and Smith (1961).

In summer, flights of the oats bug, *Limothrips cerealium*, going into aestivation and hibernation, take place at the time of the oats harvest. These thrips seek out spaces under loose bark, and even enter houses to congregate in picture frames or curtain hems where they go into a state of diapause. They do not reappear again until next spring (those in houses usually die from desiccation in the dry, artificial atmospheres). It is not known whether any thrips has a summer aestivating period as is the case in some insects, such as the coma butterfly; nor is it known whether any thrips can undergo two or more years of diapause as occurs in many sawflies and other insects.

Locomotion

Thrips are noted for their bladder-like cap at the tip of each of the tarsi (Fig. 76-79). Formerly thrips were known as Physapoda or, in German, Blasenfüsse, in reference to these bladders. Mounted specimens usually show the bladders in a collapsed state. In life, when walking at least, each bladder is turgent and is the part that touches the substrate. This manner of walking creates the illusion of toe-pirouetting ballerinas.

According to McGuffin (1937) the legs of thrips when walking move in the following sequence:

Left side	Right side
F - 1	F - 4
M - 3	M - 6
H - 5	H - 2

Certain species, especially those with greatly developed internal metafurcae to which strong muscles are attached, are capable of leaping. Leaping is apparently a good escape foil, and is most common in open-leaf feeders, particularly those species in the Dendrothripini of the Thripidae.

Ordinarily thrips are slow to take off, possibly because of the slight de-

The species introduced by man are:

AEOLOTHIRIPIDAE

- Aeolothrips albicinctus*—from Europe
- Aeolothrips fasciatus*—from Europe
- Aeolothrips melaleucus*—from Europe
- Aeolothrips vittatus*—from Europe

THRIPIDAE

- Anaphothrips obscurus*—from Europe
- Chirothrips manicatus*—from Europe
- Dendrothrips ornatus*—from Europe
- Drepanothrips reuteri*—from Europe
- Frankliniella tenuicornis*—from Europe
- Heliethrips haemorrhoidalis*—in greenhouses only, from Central and South America
- Limothrips denticornis*—from northern Europe
- Limothrips cerealium*—from middle and southern Europe
- Parthenothrips dracaenae*—in greenhouses only, possibly from Africa

- Pseudodendrothrips mori*—from Asia
- Taeniothrips simplex*—from Africa
- Thrips nigropilosus*—from Europe
- Thrips physapus*—from Europe
- Thrips tabaci*—from Europe and North Africa

PHLAEOTHIRIPIDAE

- Bagnalliella yuccae*—from the east coast of North America
- Haplothrips leucanthemi*—from Europe
- Haplothrips verbasci*—from Europe
- Nesothrips bicolor*—from Europe

A few introduced thrips once recorded from Illinois have not been retaken in recent years. Other non-American thrips, such as the pear thrips, long found on both coasts of North America, as yet have not extended their ranges to Illinois.

Our native Thysanoptera follow broad distributional patterns similar



Fig. 17.—Distribution of *Chirothrips manicatus* in Illinois.

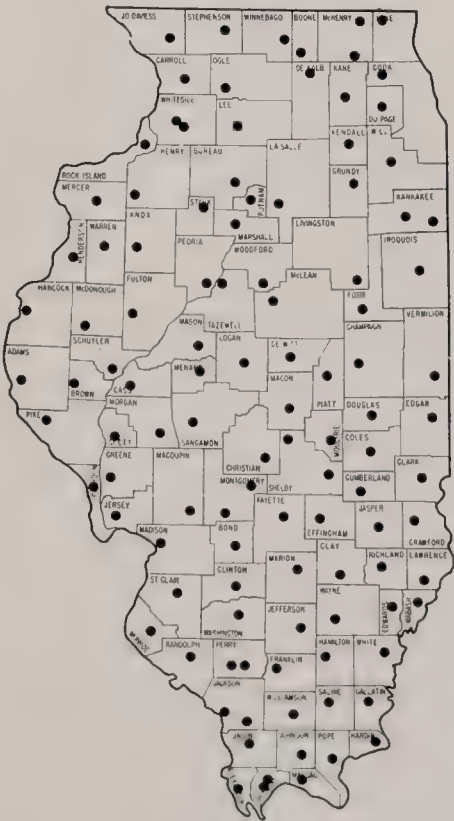


Fig. 18.—Distribution of *Haplothrips (Neohcegeria) verbasci* in Illinois.

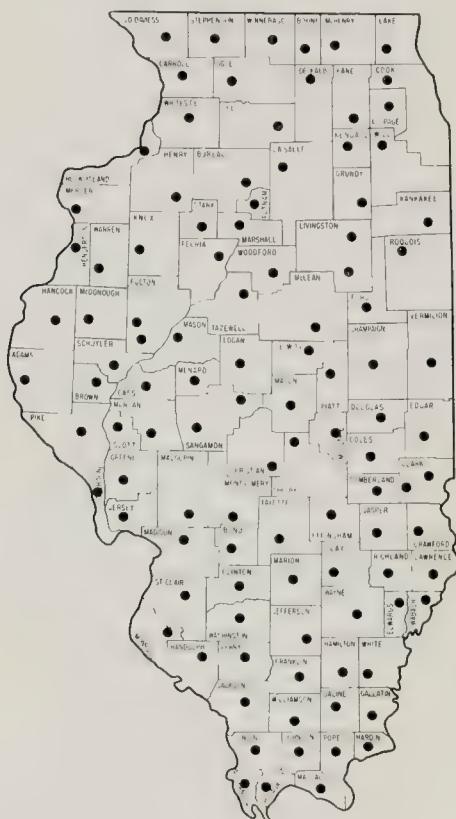


Fig. 19.—Distribution of *Bagnalliella yuccae* in Illinois.

to those of other northeastern U.S. animals (Smith 1961) and plants (Winterringer & Evers 1960). Several distinctive faunal zones occur in Illinois, and while many thrips are statewide inhabitants, a few are restricted to these various zones (Fig. 20–25).

The Austroriparian zone, particularly in Union County, is richest in numbers of species whereas the purported driftless area in the Illinoian zone (Jo Daviess County) appears to be the most depauperate. The Ozark Hills in Alexander, Jackson, Union, and Randolph counties are a unique reliquary. This is the section of Illinois that possibly bears the oldest, continuously existing, floras and faunas supposedly dating back to Miocene times when the worldwide Arcto-tertiary forest flourished there (Braun 1955). Most other areas in Illinois have at one time or another been cov-



Fig. 20.—Distribution of *Amphibolothrips (Trachythrips) watsoni*. Dots indicate localities from which specimens were collected for this study. The heavy line marks the terminal moraines of the Wisconsin glacier, modified from Horberg (1955).

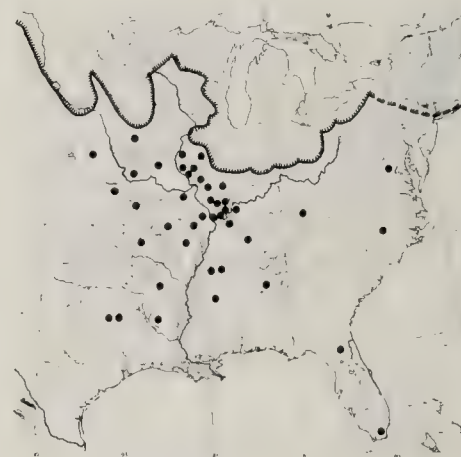


Fig. 21.—Distribution of *Allothrips nubilicauda*. Dots indicate localities from which specimens were collected for this study. The heavy line marks the terminal moraines of the Wisconsin glacier, modified from Horberg (1955).

ered by ice sheets in Pleistocene times, and because they are in more northerly regions, or because they have not yet matured geologically with the result that the diversity of environmental niches is less, the biota is poorer than in the unglaciated Ozarks. Some species of the Deep South, for

example *Scirtothrips taxodii* (Fig. 25), extend up the Mississippi river valley to southern Illinois. From another direction some eastern Appalachian species reach their northwestern limits in the Shawnee Hills, particularly in mesic valleys in Pope, Gallatin, and Hardin counties.

Some 20 or more species of Thysanoptera occur up to but not much beyond the terminal moraine of the Wisconsin ice sheet (Fig. 20 and 21). Although this ice lobe was present about 25,000 years ago, with various retreats and advances up to 10,000 years ago, it might be concluded that these thrips have not yet spread into this formerly glaciated area because their exacting environmental requirements so far have not developed on this relatively new land, and not because of time. One of these thrips, the wingless

Amphibolothrips (*Trachythrips*) *watsoni* (Fig. 20), may have expanded its range by walking a few inches or a few feet yearly since deglaciation. It has now dispersed into the Wisconsin drift area as far as La Salle and Danville along broad river valleys, but so far it has not penetrated the flat interior of the drift area.

The disputed theory that there have been one or more large faunal shifts during some supposed Xerothermic period after deglaciations (Smith 1957) lacks evidence to convince me of its possibilities. Rather it appears that conclusive evidence to the contrary is available (Stannard 1963*a*). At any rate the thrips fauna of Illinois has been strongly influenced by Pleistocene events and possibly only the southwestern tip of the state escaped much defaunization.



Fig. 22.—Distribution of *Caliothrips striatus* in Illinois.



Fig. 23.—Distribution of *Echinothrips americanus* in Illinois.

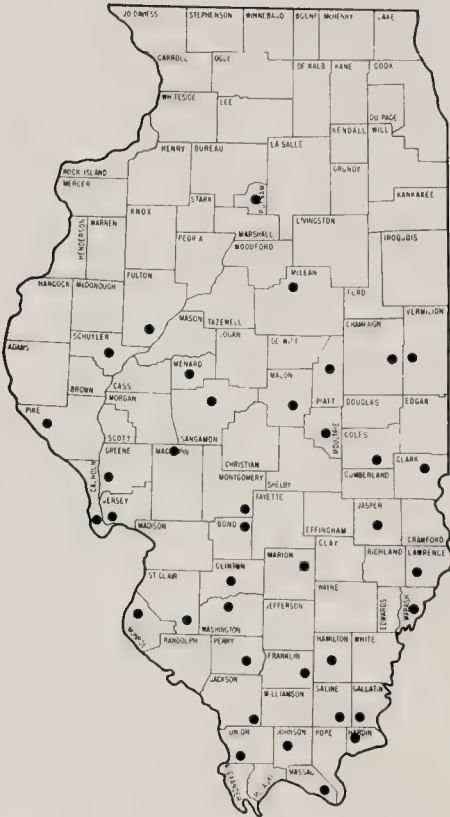


Fig. 24.—Distribution of *Leucothrips piercei* in Illinois.

In brief, it appears that the glaciated regions were repopulated by species coming from the Ozarkian refugia via the Mississippi-Illinois river valley system, and from the Appalachian refugia via the Tennessee, Kentucky, and Wabash river valley system. The distribution of the Ozarkian *Oedaleothrips hookeri* from Union County to Pere Marquette State Park along the Mississippi River and the presence of the Appalachian *Phthirotithrips morgani* and *Aeolothrips crassus* in the extreme southeastern counties, both species possible immigrants up the Tennessee river valley, are examples of these two types of dispersal. Thrips specific to hosts with archaic and limited distribution, such as *Heterothrips azaleae* restricted to *Azalea*, remain confined with their hosts. Other thrips living on widespread vegetation have more or less followed



Fig. 25.—Distribution of *Scirtothrips taxodii* in Illinois.

their hosts back onto the glaciated areas. Complete association of all thrips with their host plants over the entire range of those hosts is not always the case, however. *Liothrips usitatus*, found only on *Rhus copallina*, occurs in southern Illinois but not in northern Illinois where *Rhus copallina* sporadically reinvades our state along the Indiana borders of Will, Kankakee, and Cook counties. In the 100 or so years of intensive agricultural cultivation in Illinois, much of the original environment has either been damaged or destroyed. Whereas a widespread prairie thrips once may have been abundant, it now may be confined to but a few fence rows or along railroad tracks in an isolated clone of grass or herb. The ultimate fate of our thrips, especially those highly restricted to a rigidly cir-

cumscribed natural niche, is undoubtedly extinction except in the prairie and forest preserves protected in parks, university sanctuaries, and nature conservancy scientific areas. The bulldozer, weed killer, insecticide, fire, and other human derived forces are such continuing threats to the remaining wild habitats that the distribution of the native thrips of Illinois, as well as other species in the biota, shall become increasingly limited in future years.

Evolution

Fundamentally the Thysanoptera show strong affinities to the Corrodentia-Anoplura-Mallophaga-Homoptera-Hemiptera phyletic line of insects (Stannard 1957b). Some of the features that attest to the close relationship of these orders of insects are the homology of the maxillary stylets of the Thysanoptera with the chisel-like lacinia of the Corrodentia and the more elaborate stylets of the Homoptera-Hemiptera, together with the common reduction of the mallipigian tubules to four (or less in the higher groups); the general lack of larval ocelli (Stannard 1956a); and the similarity of the antennal sense comes as exemplified by those found on phloretsid psocids, thrips, and aphids. Because the Thysanoptera have retained maxillary and labial palps and have simplified maxillary stylets, they ought to be placed before the Homoptera-Hemiptera in phylogenetic sequence. Most members of the Homoptera-Hemiptera order have lost these palps and usually they have an extra segment in each stylet of the maxillae.

According to Grinfel'd (1959), the origin of the Thysanoptera may have been correlated with the development of the right mandible, with a corresponding reduction of the left which disappeared, as an instrument for piercing pollen granules for food. Certainly the single mandible is more effective in piercing pollen than two would be. Thus it may have been in the pollen-feeding niche that the early Thysanoptera proliferated into a full-fledged order.

The Terebrantia, on the basis of their possession of wing veins, retention of well-developed female gonopods, and in some cases three segments (instead of two) in the maxillary palps, are undoubtedly of stock more primitive than the Tubulifera (Fig. 26).

In the Terebrantia, the family Aeolothripidae—many members of which have slightly broadened wings with several longitudinal veins, nine segments in the antennae, and basically three segments in the maxillary palps—is conceded by thysanopterists to be the most generalized family. The earliest fossil, *Permothrips longipennis* Martynov, seems to be closer to the Aeolothripidae than to any other family in the Thysanoptera.

From the Aeolothripidae-like ancestor, the families Merothripidae, Heterothripidae, and Thripidae evolved. The Thripidae are the most advanced, mostly by reduction of structures or elaborations of vestiture.

Still existing today are intermediate genera, *Fauriella* and *Opisthrips*, between the Aeolothripidae and Heterothripidae, and the intermediate genus, *Erotidothrips*, between the Aeolothripidae and Merothripidae. Although the Heterothripidae and Merothripidae have often retained the nine-segmented antennae and frequently kept the flat membranous sensoria of the intermediate antennal segments, as in the Aeolothripidae, they have lost some wing veins, and male glandular-like areas on the abdominal sternites have evolved as new structures.

The family Thripidae, containing the largest number of diverse entities of the Terebrantia, specialized by having the antennae reduced to eight or seven segments (secondarily nine or six segments in some genera) and by having a further narrowing of the wings.

Throughout their evolution the Terebrantia mostly retained the propensity to feed on vascular plants and their pollen.

Possibly from an ancestor similar to members of the Heliothripini, a seemingly early derived tribe of the Thripidae, the primitive Tubulifera arose.

still represented by the single family Phlaeothripidae (Stannard 1957*b*). In their advancement the Phlaeothripidae developed longer maxillary stylets, lost almost all traces of wing veins and female gonopods, and proliferated into niches primarily involving fungi, as for

example in molding dead leaves, under bark, or on dead twigs. A few, however, still feed on juices of vascular plants or make galls.

In the evolution of the Thysanoptera a number of seemingly parallel developments occurred. These similar

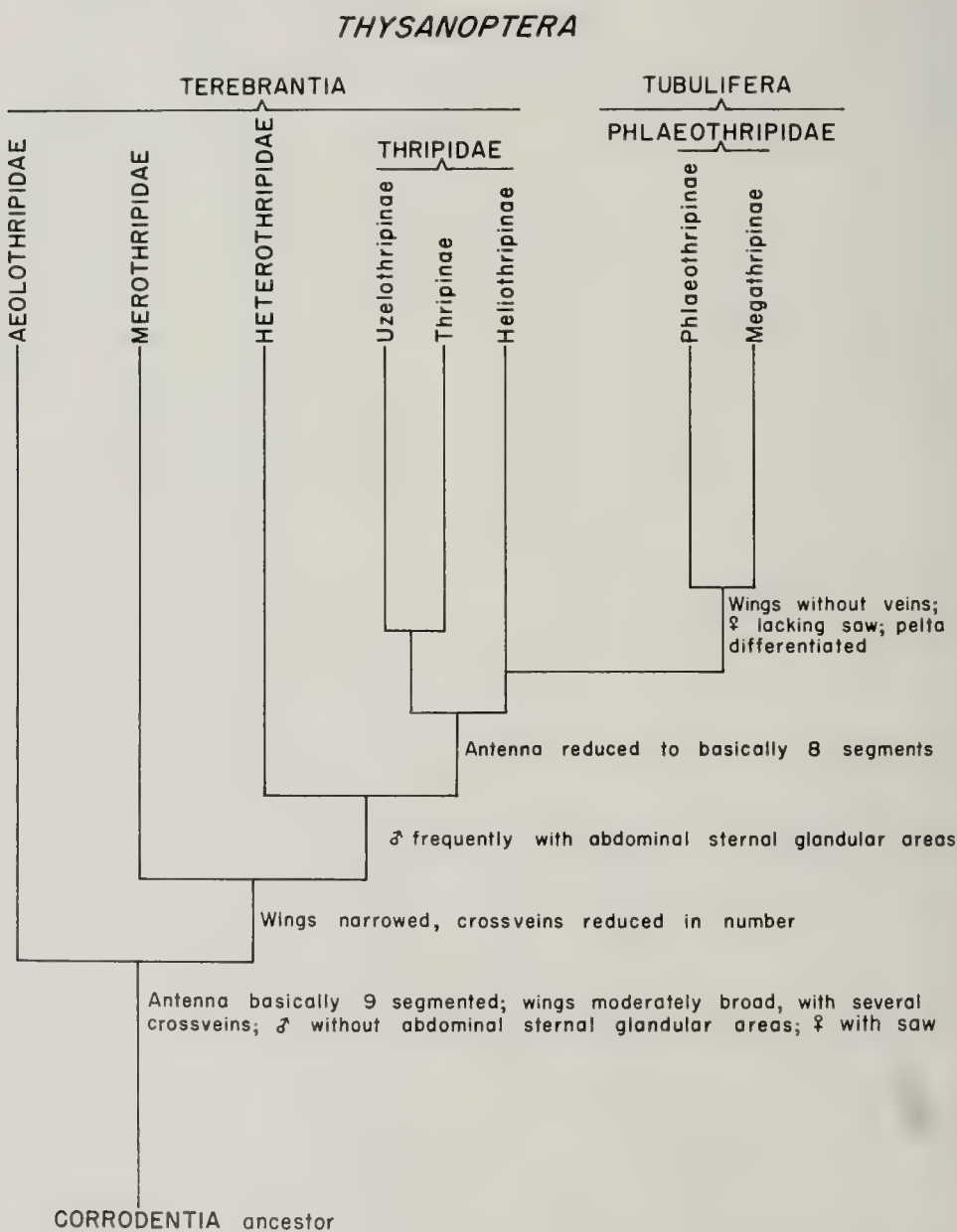


Fig. 26. Phylgenetic tree of the Thysanoptera, indicating probable origins of the major taxa.

productions of form are apparently the result of response to present environmental factors and do not necessarily reflect direct-line descent. For example, in the Terebrantia the metafurca is well developed and enlarged in thrips that are good jumpers, and this characteristic is repeated in divergent phyletic lines, the Dendrothripini, the *Sericothrips* complex, and others. In the Tubulifera certain characteristics seem to be correlated, irrespective of phyletic line, for unknown reasons or for structural compatibility. For example, in the Tubulifera, when the mouth cone is short and broadly rounded, the maxillary stylets generally are placed far apart and do not extend far (or only moderately so) into the head; the converse is ordinarily true for those thrips having a pointed mouth cone. Furthermore in the Tubulifera, it is often observed that the broader the fore wing, the closer the fringe cilia are placed together; and the greater the number of accessory fringe cilia on the fore wing, the darker in color that wing is likely to be.

A basic feature of the Thysanoptera is their cilia- or fringe-lined wings (Fig. 83), as reflected in their name. Although this type of wing is not unique in these insects, it is confined to many very small insects. For example, similar fringe wings are found in—

Coleoptera: Clambidae, Orthoperidae, Phaenoccephalidae, Ptiliidae, Sphaeridiidae

Hymenoptera: Cynipidae, Mymaridae, Trichogrammatidae

Lepidoptera: Elachistidae, Gelechiidae, Tineidae

Trichoptera: Hydroptilidae

Although the flight of small insects has been reviewed by Horridge (1956), the aerodynamic principles have not been worked out. It would seem that induced drag is disproportionately great in relationship to lift in wings as tiny as those found in thrips and others. Horridge suggests, however, that flight is possible with small wings when the drag on the upstroke is less than on the downstroke. Possibly bristles on the wings tend to reduce

the drag on the upstroke. Further, with fringes, a "slotting" effect is seemingly obtained, somewhat like the "notched" condition produced by a vulture when the primary quill feathers are spread, so that a high angle of incidence of climb in flight can be made. Thus fringed wings seemingly allow thrips to climb nearly vertically as a helicopter would upon takeoff and, thereby, gain a more favorable lift-drag ratio.

Whereas the fringe-type wing is apparently advantageous to minute insects such as thrips, this wing form may limit, by its very nature, the future size of all descendants. Before large thrips could develop, undoubtedly there would need to be a reversal in the evolution of the wings back to the broad, nonfringed type for flight.

The statistical odds of reversing the evolutionary wing trends present in the Thysanoptera are presumably so high that most likely thrips are doomed to retain fringed wings and to continue, as a consequence, as small insects in their future course of evolution.

Enemies of Thysanoptera

Despite their small size, thrips are definite parts of the food chain of many biotic communities.

Among Hymenoptera some species in *Spilomena*, *Ammoplanus*, and *Xysma* (Specioidea) provision their nests with immature Thysanoptera (Musebeck, Krombein, Townes, et al. 1951; and Krombein 1958). *Tetrastichus thripophonus* and several species of *Ceraninus* (= *Thripoctenus*) (Eulophidae) also select Thysanoptera as hosts (Russell 1912, Mason 1922, Bailey 1933, and de Santis 1961). The tiny wasp, *Megaphragma mymaripenne* (Trichogrammatidae), develops within the eggs of thrips (McMurtry 1961). Another minute wasp, *Dasyscarpus parvipennis*, has been used in Maryland to aid in the control of greenhouse thrips and in California for thrips that feed on avocado (McMurtry & Johnson 1963).

In the Diptera, immature stages of Syrphidae, for example *Sphaerophoria*,

are predators of Tubulifera (Stuckenberg 1954). Larvae of Cecidomyiidae are said to be predacious on the olive thrips (Melis 1935).

In addition, insects belonging to the families Anthocoridae (Fig. 27), Coccinellidae, Staphylinidae, Cucujidae, and Chrysopidae, as well as mites of the families Laelaptidae, Cheyletidae, and Amystidae have been reported attacking thrips (Bailey 1933, Melis 1935, and Illingworth 1931). Russell (1912) further records a nematode parasite of the bean thrips.

Even certain predacious thrips, *Aeolothrips*, *Franklinothrips* (Fig. 28), *Scolothrips*, and *Aleurodothrips*, occasionally feed on other thrips (Bailey 1933, McMurtry 1961, and Ebeling 1950), and instances of cannibalism have been observed (Grinfel'd 1959).

Both Shull (1911) and Hood (1914c) surmise that hummingbirds eat flower thrips, in the temperate region as well as in the tropics.

Several thrips have been described from specimens taken from the stomachs of lizards, *Anolis stratulus* and *pulchellus* (Morgan 1925a). Knowlton (1938) has recorded Thysanoptera from the stomachs of the lizards *Uta s. stansburiana* and *Sceloporus g. graciosus*. Recently Moll (1963) recovered *Frankliniella tritici* from the stomach of smallmouthed salamanders (*Ambystoma texanum*) in Illinois in the sum-



Fig. 28.—Larva of *Franklinothrips vespi-formis* feeding on another thrips larva. Photo by Walter Ebeling, University of California.

mer. Hamilton (1930) found thrips in all but a few stomachs of young American toads examined.

Besides predators and parasites, many hazards of climate and change in the environment destroy Thysanoptera. Heavy rains are said to be responsible for reducing populations of thrips that are pests on crops (Russell 1912). Fire in particular is deleterious to colonies of thrips living in leaf duff and crowns of prairie clump grasses. Burned prairies are especially depauperate in native Thysanoptera, particularly those thrips which are usually flightless. Information on the rate of recolonization of devastated areas is scarce. In one study conducted in Illinois, eight species of native prairie thrips had not returned to an area once treated by the insecticide dieldrin even after a period of eight years (Moye, Stannard, & Luckmann, 1966).



Fig. 27. Nymphs of *Ectemnus reduvinus* (Anthocoridae) feeding on *Liothrips oleae* in southern Europe. From Melis (1935).

ECONOMIC IMPORTANCE

Bailey (1940) has listed the 32 thrips most destructive to crops in the United States. Many of these same thrips cause concern in Europe and other temperate regions. Elsewhere, Ananthakrishnan (1956) has reviewed the worst thrips pests of India, several of which are also found in other countries with tropical climates. Some thrips of economic importance in the Neotropical regions are discussed by Ebeling (1950).

In Illinois, a number of thrips, mostly introduced species, can cause serious direct damage to crops. Among these *Taeniothrips simplex* is of importance to commercial gladiolus growers in the Kankakee area. Another, *Thrips tabaci*, must be controlled in the onion-growing areas south of Chicago, although many of the farmers believe that in some cases a mild infestation of thrips may help thin closely grown seedling onions. Rose and chrysanthemum growers must protect against the flower thrips, *Frankliniella tritici*, sometimes even in the winter in greenhouses. Fruit growers in nearby Indiana have reported dimpling of apples by the same flower thrips in the spring (Anonymous 1963a). The grass thrips *Anaphothrips obscurus* causes silver top of blue grass (Fig. 99), and occasionally damages young corn so severely that replanting is necessary. In addition a number of species of grass thrips infesting grains and pastures cause varying degrees of production losses (Bailey 1948; Rihard 1954). Other important thrips include *Limothrips cerealium* which can destroy oats crops (Körting 1930) and *Dendrothrips ornatus* which attacks privet hedges and lilacs, especially in the northern and central portions of Illinois.

Besides causing mechanical injury, some thrips transmit plant virus diseases. *Frankliniella fusca* and *Thrips tabaci* have been shown to transmit tomato spotted wilt virus (Sakimura 1963), although their role in spreading this plant disease in Illinois is not known.

On the other hand some thrips—*Scolothrips pallidus*, *Haplothrips* (*Haplothrips*) *subtilissimus*, and *Haplothrips* (*Leptothrips*) *mali*—feed on spider mites or small insects and thus are of benefit to horticulturists.

As a nuisance, *Limothrips cerealium* often enters houses and settles everywhere—hardly a crack or hem is too small for it to penetrate. Several species of thrips can also be mildly annoying when they bite a person's bare arm or head. Bailey (1936) has listed the names of those thrips that have been known to bite human beings. Westwood (1840) repeats the supposedly reliable story of the person who, suffering from headache, discharged thrips which had lodged in his nostrils. Such mishaps are apparently rare and should not be considered as a particular trait of thrips in general.

Negative reaction to thrips by bees was mentioned by Parks (1927). He wrote that there were many records of bees not working mesquite because of the presence of thrips in the bloom.

FAUNAL MONOGRAPHS IN NORTH AMERICA

At the time (1895) of Uzel's monograph of the Thysanoptera in which about 160 names of extant species were recorded for the world, Alice M. Beach published the first list of thrips in North America, a list of 17 species from Iowa. Some of these species were then regarded as varieties. (By 1936 Moulton & Andre raised the total of known Iowan thrips to 85 species, and in later records the number was further increased.) Following Miss Beach, Hinds (1902) treated about 39 species, as now recognized, for the whole of North America. Subsequently Daniel (1904) published a list of eight species for California. More recently Cott (1956) and Bailey (1957) keyed and described a total of 182 California species, climaxing years of discovery and study by thysanopterists.

The growth of knowledge of the North American fauna was fairly

rapid. Within 10 years after Hinds' monograph, Moulton (1911) had increased the number to about 115 species as currently recognized. Watson (1924a) enumerated about 335 species for our continent including a few names that have since been synonymized. In 1926 Hood and Herrick recorded 74 species from the state of New York alone. Additional partial and small lists, several in unpublished theses, have been prepared for Indiana, Florida, Oregon, North Carolina, New Jersey, and other states. Without listing the names, Hood (1954a) stated that 213 species were known in Florida. My revision of the Tubulifera (1957b) included 486 species in this suborder for North America from Alaska to Panama.

The treatments given by Bailey and Cott for California, as previously mentioned, are comprehensive modern guides suitable for many of the states west of the continental divide. The Illinois report presented herewith covers 225 species including some not yet found within the state borders and the keys are designed to include all genera in states east of the 100th meridian.

The faunas of Texas, the Southwest, the central plains states, and Canada still need to be investigated more thoroughly, at least at the "beta" level that Bailey, Cott, and I have done on the West and East, before a reasonable idea can be gained of the kinds and overall distribution of our temperate North American thrips. Probably this fauna will amount to nearly 500 species out of a world total of 4,500–5,000 known species. (In 1960 Dr. Zur Strassen counted 4,050 names of species as of then proposed for the Thysanoptera in the extensive card index maintained by Dr. J. C. Faure.)

COLLECTING AND PRESERVING THYSANOPTERA

Thysanoptera may be collected by three general techniques—sweeping, beating, and the Berlese extraction method. Direct observations of plant leaves are advisable also, especially for

light-colored species such as those on redbud, *Tilia*, *Sambucus*, and mulberry.

A heavy sweeping net, when swept over grasses, herbs, and shrub or tree leaves, yields an initial survey of the active thrips of an area. If a mixed stand of vegetation is swept for thrips, it may be necessary to retrace the area covered, examining each species of plant until the actual host of a particular thrips previously captured can be ascertained.

A broad, flat cloth (Fig. 29) is excellent for receiving thrips dislodged by beating dead branches or by shaking flowers and leaves. After the beating, the cloth can be carefully searched for thrips as the fallen individuals delay many minutes before taking to flight. In an emergency, a piece of cardboard, or one's shirt, can be used as a substitute for the collecting cloth.

Once located, the thrips may be lifted from surfaces by touching them with a fine, moistened, watercolor brush. Adhering specimens may then be shaken off into a vial of preserving fluid.

Many cryptic thrips of the humus and bark can be collected by sifting the material over a cloth, but by far the easier method is the Berlese method. Leaf mold on the forest floor (Fig. 30), moss, old nests, bark, or freshly dug grass clumps (Fig. 36) can be put into Berlese funnels (Fig. 31), which are heated by suspended, glowing, light bulbs or encircling steam or hot water pipes. The tips of the funnels are inserted into bottles of 70-percent alcohol. Thrips and other insects are driven down and out of the substrate by the heat, and fall into the alcohol (Fig. 32).

A suitable fluid (AGA) made of eight parts of 95-percent alcohol, five parts of water, one part of glycerine, and one part of glacial acetic acid kills and preserves thrips in a relaxed condition, allowing them to be easily mounted. After several months in AGA, the specimens should be mounted or stored in 70-percent alcohol.

Although Hoyer's medium (Baker & Wharton 1952:10) is excellent for



Fig. 29. Beating and jarring leaves and branches over cloth to collect Thysanoptera. Photo by W. E. Clark.

making whole mounts of thrips, it is not always long lasting. For the permanent collection, thrips should be mounted in balsam.

In making balsam mounts it is advisable to remove the thrips from AGA to 70-percent alcohol, and pierce a hole in the abdomen with a fine, sharp pin. This hole allows for quick passage of balsam into the body to prevent collapsing. From the 70-percent alcohol solution change the thrips to 95-percent alcohol and then briefly to oil of wintergreen to fix the tissues prior to placement in balsam on the slide. Pieces of glass (fragments of broken cover slips will serve) placed to the anterior and posterior of the specimen before the cover slip is put in place prevent eventual mashing and distortion by the cover slip as the medium hardens. Wings and legs should be spread for clear vision. Customarily thrips are mounted dorsal side up. Very dark specimens might



Fig. 30.—Collecting forest litter for processing in Berlese funnel to recover thrips in the leaf mold habitat. Photo by Wilmer Zehr.

be macerated with KOH treatment prior to mounting.

A good research microscope (Fig. 33) with a high dry (40 times magni-



Fig. 31. —Berlese funnels in operation. Forest litter is placed in funnels and then warmed and dried by heat to drive insects down into bottles of preservative (70-percent alcohol) below. Photo by Wilmer Zehr.

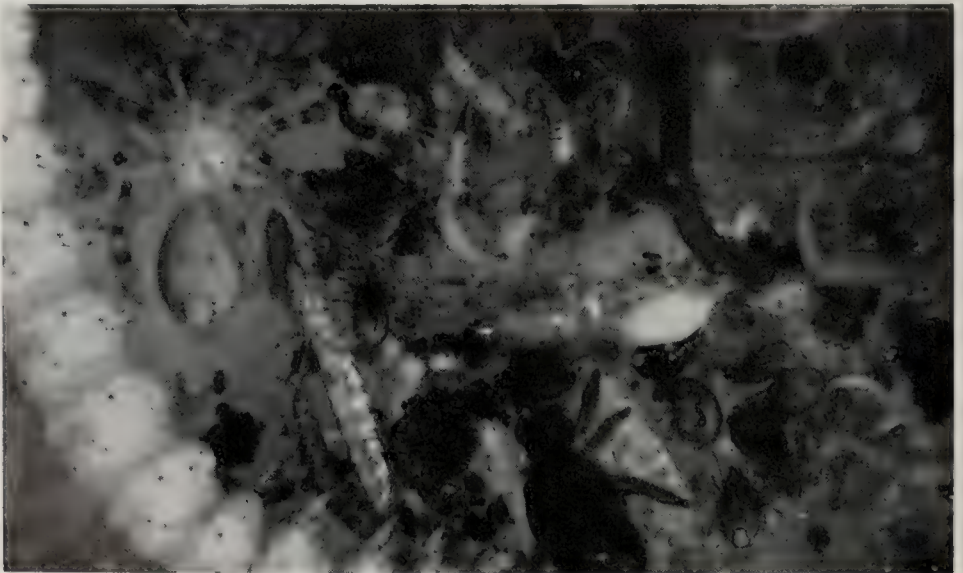


Fig. 32. Samples of insects, including thrips, recovered from forest litter by the Berlese funnel method. Photo by Wilmer Zehr.

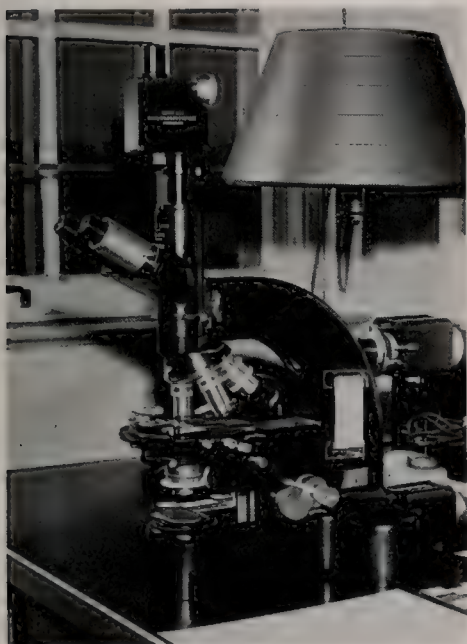


Fig. 33.—Type of research microscope needed for the study of Thysanoptera. Photo by Wilmer Zehr.

fication) objective and with a light source that can be adjusted for Köhler illumination is necessary for the study of Thysanoptera. A hand lens of 20 power magnification is useful in making observations in the field.

Not all thysanopterists are in agreement on every phase of collecting or mounting thrips, or even in storing the slides. The search for the perfect mounting medium still goes on. Meanwhile, however, the major collections of Thysanoptera in the world are composed primarily of specimens preserved in balsam on 3- by 1-inch, 1 mm thick slides, stored in boxes or trays. Such uniformity allows much convenience in exchanging specimens.

In learning to recognize the subtle features of many of the genera and species of thrips, it is advantageous to have a named reference collection available. Lacking access to such a collection, a helpful series of specimens can be gathered from hosts known to harbor specific thrips. In this manner representatives, especially of the Terebrantia, can be obtained

quickly and identified with reasonable assurance of accuracy.

The following partial list should aid in this regard:

Plant Hosts of Thysanoptera of Illinois

TEREBRANTIA

<i>Aeolothrips vittatus</i>	conifers
<i>Aeolothrips vittipennis</i>	locust trees
<i>Heterothrips aesculi</i>	red buckeye flowers
<i>Heterothrips analis</i>	wild rose flowers
<i>Heterothrips arisaemae</i>	jack-in-the-pulpit flowers
<i>Heterothrips auranticornis</i>	flowers of sunflowers, autumn
<i>Heterothrips azaleae</i>	flowers of azalea
<i>Heterothrips quercicola</i>	oak catkins
<i>Heterothrips salicis</i>	male catkins of sand bar willow
<i>Heterothrips vitis</i>	opening buds of grape flowers
<i>Anaphothrips sandersoni</i>	heads of slough grass
<i>Caliothrips striatus</i>	leaves of yellow poplar
<i>Ctenothrips bridwelli</i>	leaves of may apple, skunk cabbage
<i>Dendrothrips ornatus</i>	leaves of privet hedge, lilac
<i>Drepanothrips reuteri</i>	leaves of grape
<i>Leucothrips piercei</i>	leaves of redbud
<i>Pseudodendrothrips mori</i>	leaves of Japanese mulberry
<i>Scirtothrips brevipennis</i>	red cedar
<i>Scirtothrips taxodii</i>	bald cypress
<i>Sericothrips annulipes</i>	leaves of locust trees
<i>Sericothrips baptisiae</i>	false indigo
<i>Sericothrips beachae</i>	leaves of hops
<i>Sericothrips campestris</i>	leaves of wild four-o'clock
<i>Sericothrips langei</i>	leaves of <i>Nymphaea</i> water lily
<i>Sericothrips pulchellus</i>	leaves of wafer ash
<i>Sericothrips sambuci</i>	leaves of elderberry
<i>Sericothrips tiliae</i>	leaves of linden

Taeniothrips betulae . . . leaves of willow
Taeniothrips simplex gladiolus
Taeniothrips vulgarissimus
 cow parsnip
Thrips impar jewel weed
Thrips monotropae
 flowers of Indian pipe
Thrips pallicornis hickory
Thrips physapus dandelion
Thrips varipes
 flowers of leather flower
Thrips winnemanae
 leaves of coral berry

TUBULIFERA

Bagnalliella yuccae
 sheaths of yucca (Fig. 34)
Haplothrips aculeatus grasses
Haplothrips leucanthemi
 flowers of daisy
Haplothrips malifloris
 leaves of *Frolechia*
Haplothrips shackelfordi . . . slough grass
Haplothrips verbasci
 leaves and flower buds of mullein
Liothrips citricornis
 leaves of hickory
Liothrips pruni . . . under bark of cherry
Liothrips russelli
 leaves of virginia creeper (Fig. 35)
Liothrips usitatus
 buds of dwarf sumac
Malacothrips zonatus
 clump grass (Fig. 36)

Elaphrothrips coniferarum conifers
Elaphrothrips tuberculatus
 hanging dead oak leaves (Fig. 37)



Fig. 35.—Virginia creeper, host plant of *Liothrips russelli*. Photo by Wilmer Zehr.



Fig. 34. *Yucca filamentosa*, host plant of the thrips, *Bagnalliella yuccae*. Photo by Wilmer Zehr.



Fig. 36.—Clump of *Andropogon gerardi*, host plant of several native prairie thrips. Photo by Wilmer Zehr.



Fig. 37.—Dead hanging oak leaves, niche of *Elaphrothrips tuberculatus*. Photo by Wilmer Zehr.

GREENHOUSE THRIPS

(* = not yet found in Illinois)

- **Aleurodothrips fasciapennis*
- Anaphothrips obscurus*
- **Asprothrips antennatus* Moulton
(= *raui* Crawford, new synonymy)
- Chaetanaphothrips orchidii*
- **Frankliniella occidentalis*
- Frankliniella tritici*
- **Franklinothrips vespiformis*
- Heliothrips haemorrhoidalis*
- **Leucothrips nigripennis*
- **Liothrips vaneeckei*
- Parthenothrips dracena*
- **Taeniothrips xanthius*

EXTERNAL MORPHOLOGY

Modern investigations of the morphology of the Thysanoptera have been done by several students. Among these, Doekson (1941) illustrated and described in the Dutch language both the Terebrantia and the Tubulifera. Pesson (in Grassé 1951) gave an exceptionally thorough treatment of both suborders in French. Melis (1959) also described in detail the principal structures of both suborders in Italian.

Jones (1954), reported in English on the external morphology of *Chirothrips hamatus* (Terebrantia), and Davies (1958) presented an analysis of the morphology of the head and mouth parts of the Thysanoptera as based on knowledge of the musculature. Priesner (in Tuxen 1956) described the genitalia and secondary sexual appendages. Peterson's work (1915) on the heads of both suborders still stands as a fundamental reference. Other contributions to the morphology of thrips are found scattered in the various taxonomic papers.

The principal characteristics which are used herein for taxonomic purposes are illustrated and named in the several accompanying outline drawings (Fig. 38-61). Additional or singular characteristics are described or illustrated on subsequent pages when appropriate.

Although no morphological feature is absolutely indicative of a taxonomic level, certain structures have proved to be generally useful in the separation of the major groups in the Thysanoptera.

At the family level, the overall form of the antennae and the sense cones, the shape of the fore wing including the venation and setae, and the secondary sexual structures, particularly the ovipositor, glandular areas, and spines, tend to serve as the principal key characters.

At the generic level, details of the antennae, the length and type of setae, the placement of the maxillary stylets (in the Tubulifera), body sculpture, and fore leg armature are frequently used as the main, basic characteristics.

At the specific level, color and chaetotaxy are the most useful spot characteristics. The head shape, individual antennal segment lengths, arrangement of the prothoracic and wing setae, sculpture of the metanotum, and the shape of the pelta (in the Tubulifera) are also often diagnostic.

Some structures, such as ordinary setae, may serve functions incidental to the thrips well-being. These setae may act as pollen holders and thereby

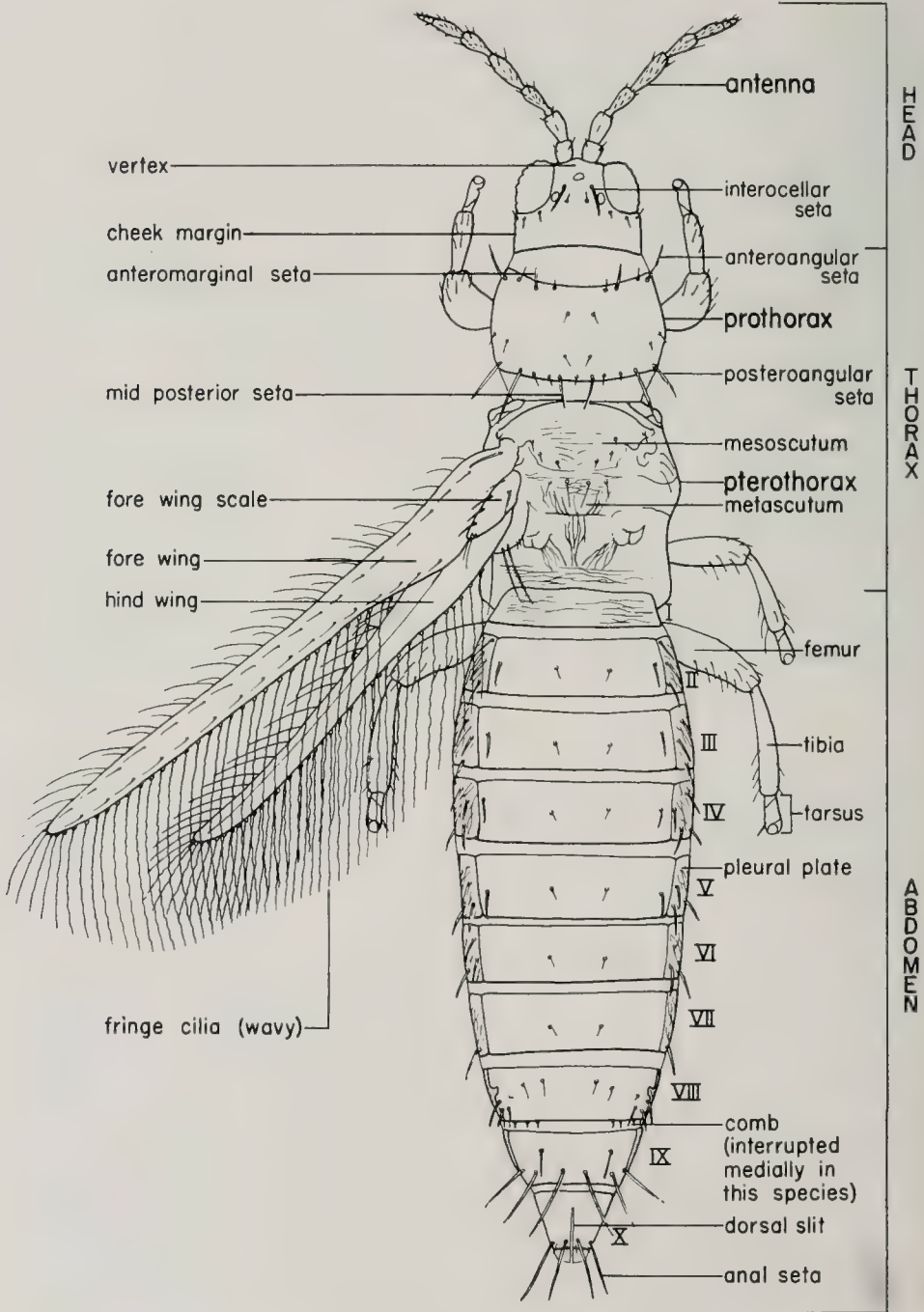
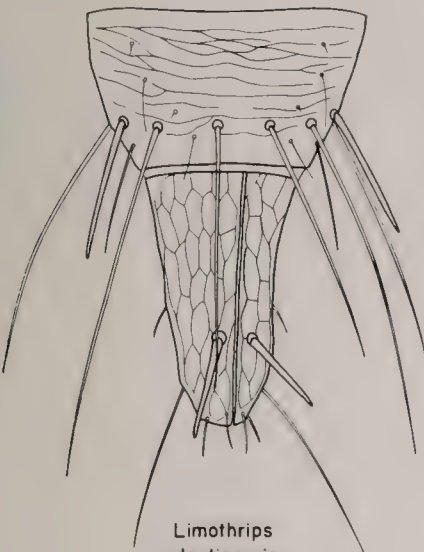
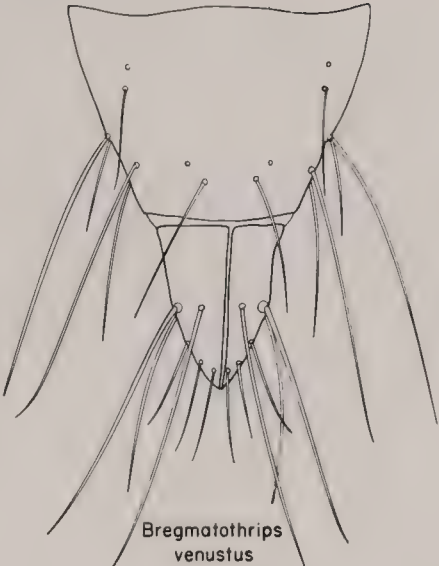


Fig. 38. Morphological features of the Terebrantia as exemplified by *Frankliniella tritici*, dorsal aspect.



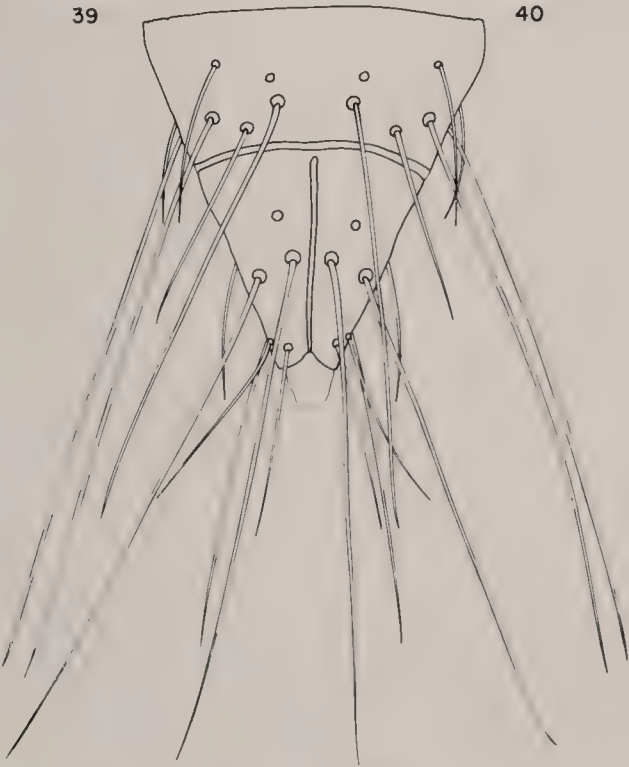
Limothrips
denticornis

39



Bregmatothrips
venustus

40



Plesiothrips *perplexus*

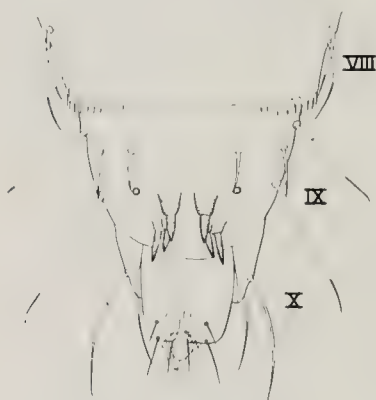
41

Fig. 39-41.—Abdominal terminalia, ♀, of the Thripidae as exemplified by species indicated.

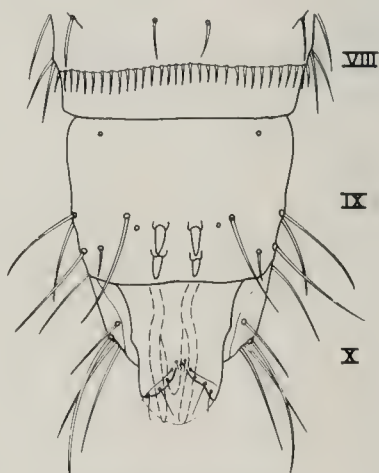
be of advantage to the host plant. According to observations by Shaw (1914) most of the thrips examined from beet flowers in Ogden, Utah, bore among their body setae numerous pollen grains. Annand (1926) noted that "Thysanoptera having heavy well-developed bristles are better able to carry pollen grains on the body." Whether particular setae have evolved into their special form as pollen traps is an unanswered question.

Morphological characteristics that

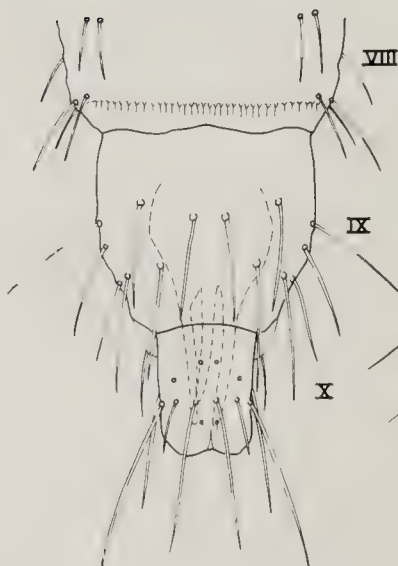
separate the sexes are more obvious in the Terebrantia than in the Tubulifera. In the Terebrantia, the female bears a conspicuous sawlike ovipositor whereas this structure is absent in the male. In the Tubulifera, the female may be recognized by a short, internal rod (fustis) lying just forward of the base of the tube (abdominal segment X) (Fig. 53, F.). By contrast, the male tubuliferon lacks the rod and has the central portion of the basal sternal margin of the tube incised (Fig. 52).



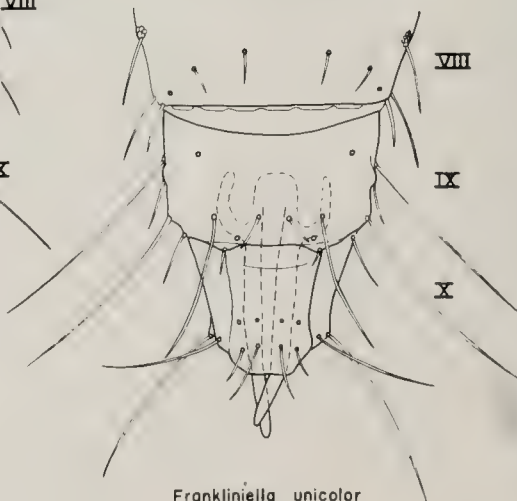
Hercinothrips femoralis
42



Anaphothrips sandersoni
43

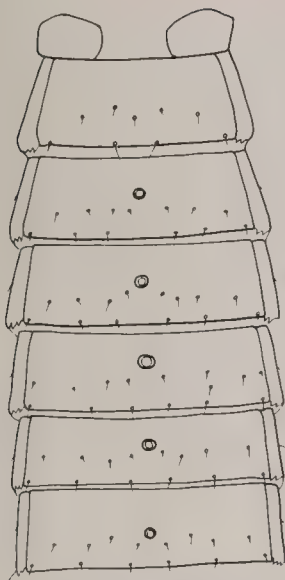


Echinothrips americanus
44

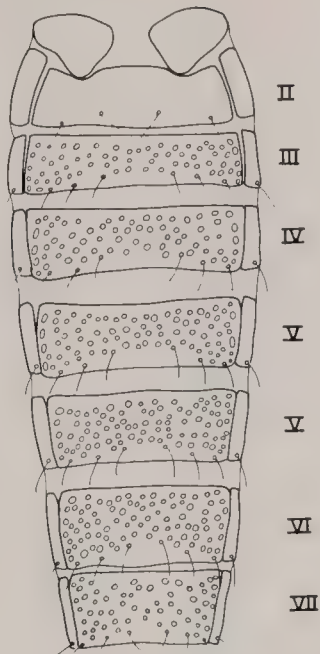


Frankliniella unicolor
45

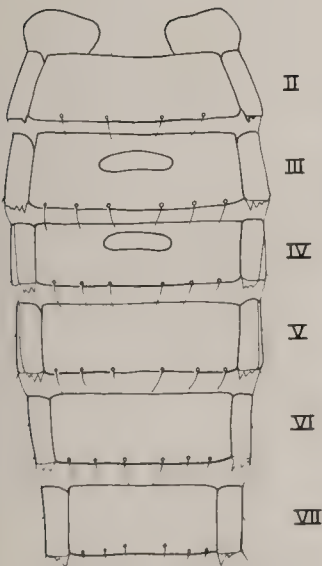
Fig. 42-45. Abdominal terminalia, ♂, of the Thripidae as exemplified by species indicated. Fig. 42 from Hood, in White (1916).



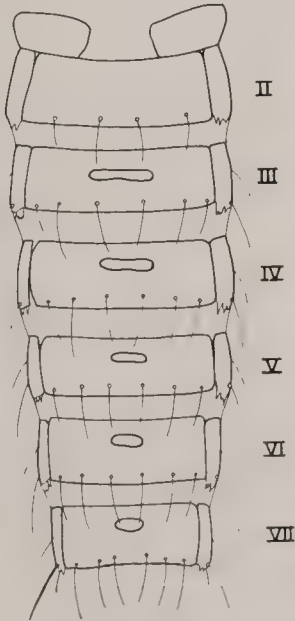
Limothrips cerealium
46



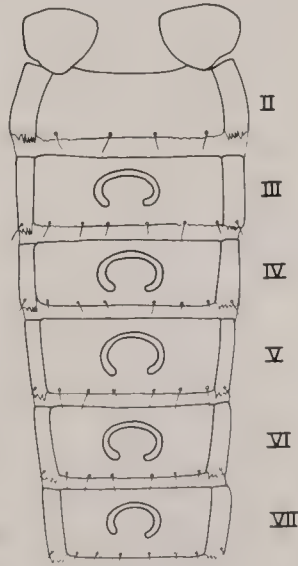
Echinothrips americanus
47



Thrips pallicornis
48



Thrips impar
49



Anaphothrips catawba
50

Fig. 46-50. Types of glandular areas on abdominal sternites, ♂, of the Thripidae as exemplified by species indicated.

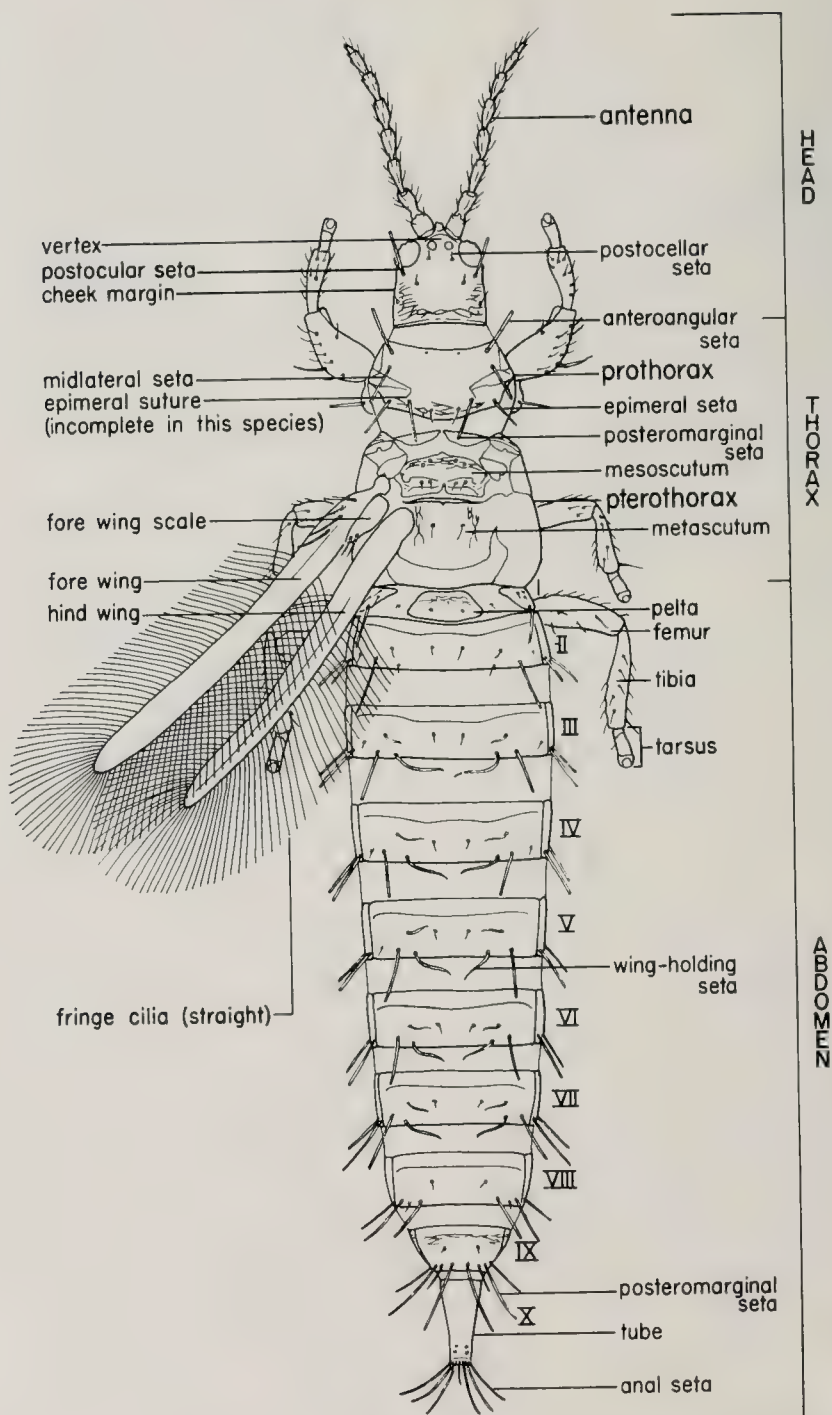


Fig. 51.—Morphological features of the Tubulifera as exemplified by *Eurythrips ampli-ventralis*, dorsal aspect.

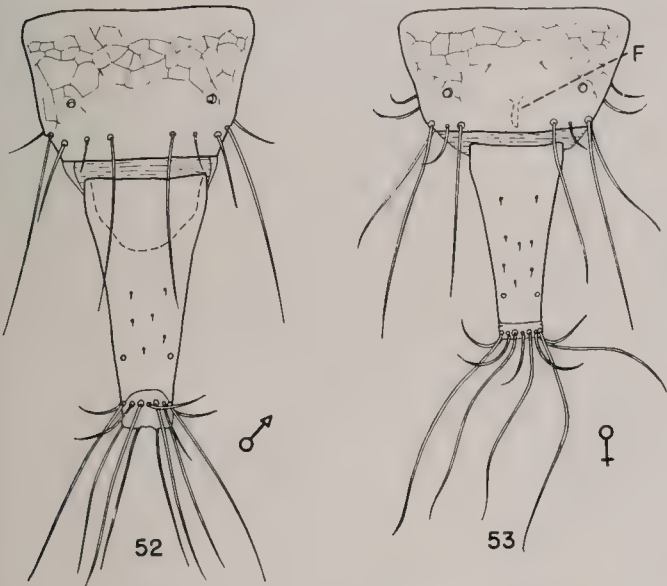
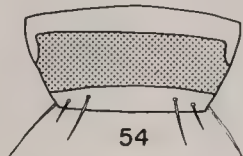
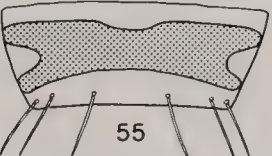


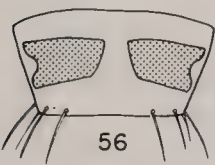
Fig. 52-53.—Secondary sexual characteristics of the abdominal terminalia useful in distinguishing the sexes in the Tubulifera as exemplified by *Hoplothrips pergandei*: 52, ♂; 53, ♀. F—fustis.



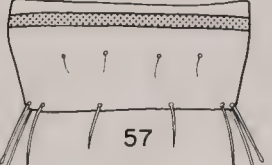
Eurythrips ampliventralis



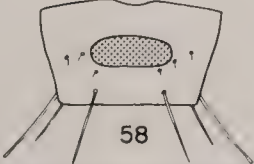
Eurythrips tarsalis



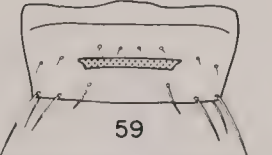
Eurythrips batesi



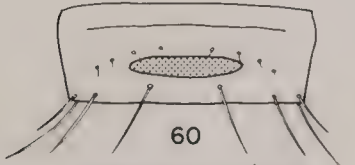
Erkosothrips interior



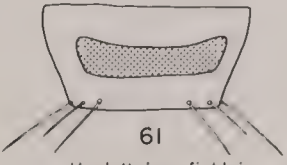
Adraneothrips exiguus



Acanthothrips nodicornis



Hoplothrips americanus



Hoplothrips fieldsi

Fig. 54-61.—Types of glandular areas on abdominal sternite VIII, ♂, of the Phlaeothripidae as exemplified by species indicated.

TAXONOMIC TREATMENT

Order THYSANOPTERA

Haliday 1836

1744—genus *Physapus* DeGeer

1758—genus *Thrips* Linneaus

1806—family Vesitarses or Physapodes Duméril

1814—family Thripsides Fallén

1835—order Thripsites Newman

1836—order Thysanoptera Haliday

1838—order Physapoda Burmeister

1855—order Thripsina Newman

Extremely small pterygote insects, averaging between 1.5 and 2 mm in length (extremes 0.6 and 14 mm). Body frequently sculptured or setose, with three or four pairs of spiracles.

Head opisthognathus, i.e., base of mouth parts directed posteriorly. Antennae composed of four to nine segments, these often with thin-walled sensoria. Adults usually bearing compound eyes or closely set facets; larvae with eyes reduced, composed of only a few facets. Ocelli often present in adults, never in larvae or pupae. Left mandible atrophied, right mandible stylet-like. Lacinae of maxillae prolonged into stylets, which when retracted extend into the mouth cone or into the head sometimes as far as up to the eyes. Labial and maxillary palps present, usually reduced to a few segments. Mouth parts forming an asymmetrical cone.

Prothorax moderately large, often with strong tactile setae at outer angles. Pterothorax often bearing four membranous wings which are bordered with long fringe cilia; wing veins reduced to a few major veins or absent. Wings occasionally reduced in size to pads or apterous. Legs each with one or two tarsal segments terminating in claws and a bladder; sometimes legs with spurs or especially elaborated setae.

Abdomen consisting of 10 well-defined segments, segment XI rudimentary, segment I closely attached to pterothorax. Often dorsal abdominal setae modified as wing-holding setae, lateral setae usually becoming longer on the apical segments. With or without glandular-like areas on certain sternites. Terminal segment cylindri-

cal or tapering as a cone. Anal setae long. With or without sawlike ovipositor. Cerci absent.

Sexual dimorphism frequently occurring. Oviparous or oviparous. Eggs oval to reniform. Larval stages two, pupal stages one, two, or three.

Existing as a recognizable order since Permian times. Most numerous today in tropical regions, less abundant in temperate zones, scarce in arctic areas.

Customarily the Thysanoptera are arranged in two suborders and five families.

KEY TO SUBORDERS

ADULTS

- Last abdominal segment (X) tubelike; female without sawlike ovipositor; major anal setae arising from platelets attached to end of tube.suborder **Tubulifera**
 Last abdominal segment rarely tubelike; female always with sawlike ovipositor; major anal setae arising from subapical region of abdominal segment X, never from separate terminal platelets.suborder **Terebrantia**

IMMATURES

1. Antennae distinctly segmented; wing sheaths never present (Fig. 5 and 9).LARVAE 2
 Antennae fused into a sheath that is rarely segmented; wing sheaths present or absent (Fig. 11 and 13).PUPAE 3
2. Intermediate antennal segments with microsetae bearing rings (Fig. 6 and 7); abdominal segment X seldom tubelike, with anal setae arising from apex.**Terebrantia**
 Antennal segments smooth, not ringed (Fig. 9 and 10); abdominal segment X usually tubelike, often strongly sclerotized and tanned, with anal setae arising from separate platelets.**Tubulifera**
3. Antennal sheath either extended forward of head or lying over the head, often reaching to the pronotum (Fig. 8).**Terebrantia**
 Antennal sheath either hornlike and curved around head, or aligned along side of head, often reaching below the prosternum (Fig. 12-14).**Tubulifera**

All of the subsequent keys presented herein pertain to adults known to occur in Illinois and neighboring states unless otherwise stated.

Records, if only a few, are given with full data; if there are many, the data are summarized and localities are listed by counties only. All records are documented by specimens in the col-

lections of the Illinois Natural History Survey (INHS) unless otherwise noted.

Body length is given in this report as being exclusive of the antennae and projecting setae.

Suborder TEREBRANTIA

Antennae six to nine segmented (Fig. 62-75), with sensoria in the form of flat surface areas or raised and seta-like, often forked. Postocular setae usually minute or absent. Maxillary stylets usually confined to or within the mouth cone, not much retracted into the head when at rest. Maxillary palps two or three segmented, secondarily many segmented.

Prothoracic notum rarely with epimeral sutures; sternum without praepectal plates, often setose or granular. Mesopraesternum absent. Mesospina-sternum separate or fused to meta-

sternum. Tarsi each one or two segmented, never both conditions in same species. Wings when fully developed usually with one or several longitudinal veins, with microsetae, with fringe cilia straight or wavy, parallel when at repose over abdomen.

Abdominal tergite I usually entire, without pelta, with stippled membranous posterior border. Abdominal segments often with pleural plate, never with dorsal sigmoidal wing-holding setae. Females with a sawlike ovipositor, which in some species may be degenerate. Males often, and females occasionally, with sternal glandular-like areas. Abdominal segment X often tapered, rarely tubular. Major anal setae arising directly from abdominal segment X.

Pupal instars usually two, secondarily one in number.

Contains four families: Aeolothripidae, Heterothripidae, Merothripidae, and Thripidae.

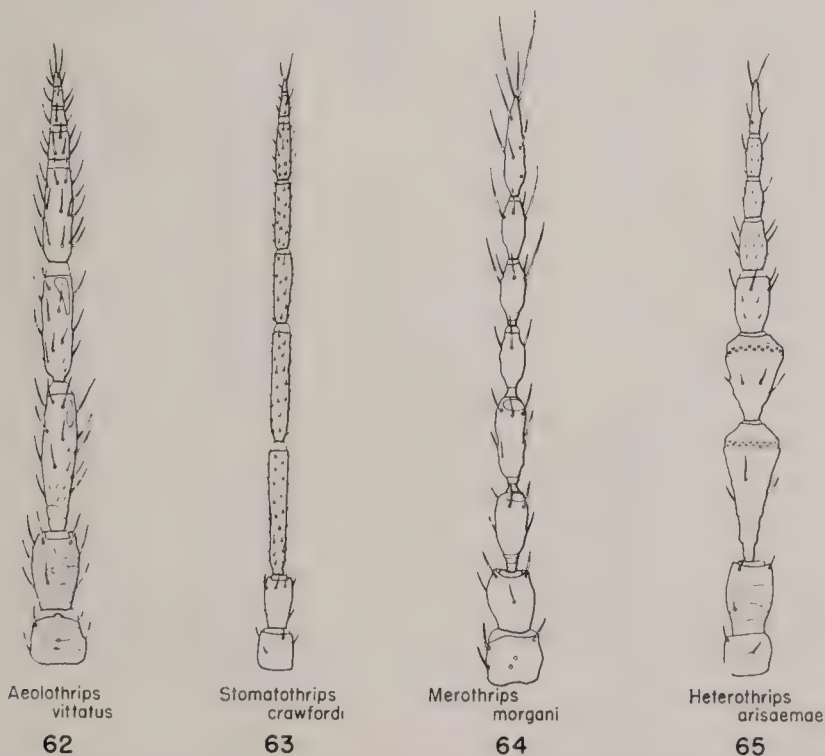


Fig. 62-65. Right antenna, dorsal aspect, of species indicated, representatives of the Aeolothripidae, Merothripidae, and Heterothripidae.

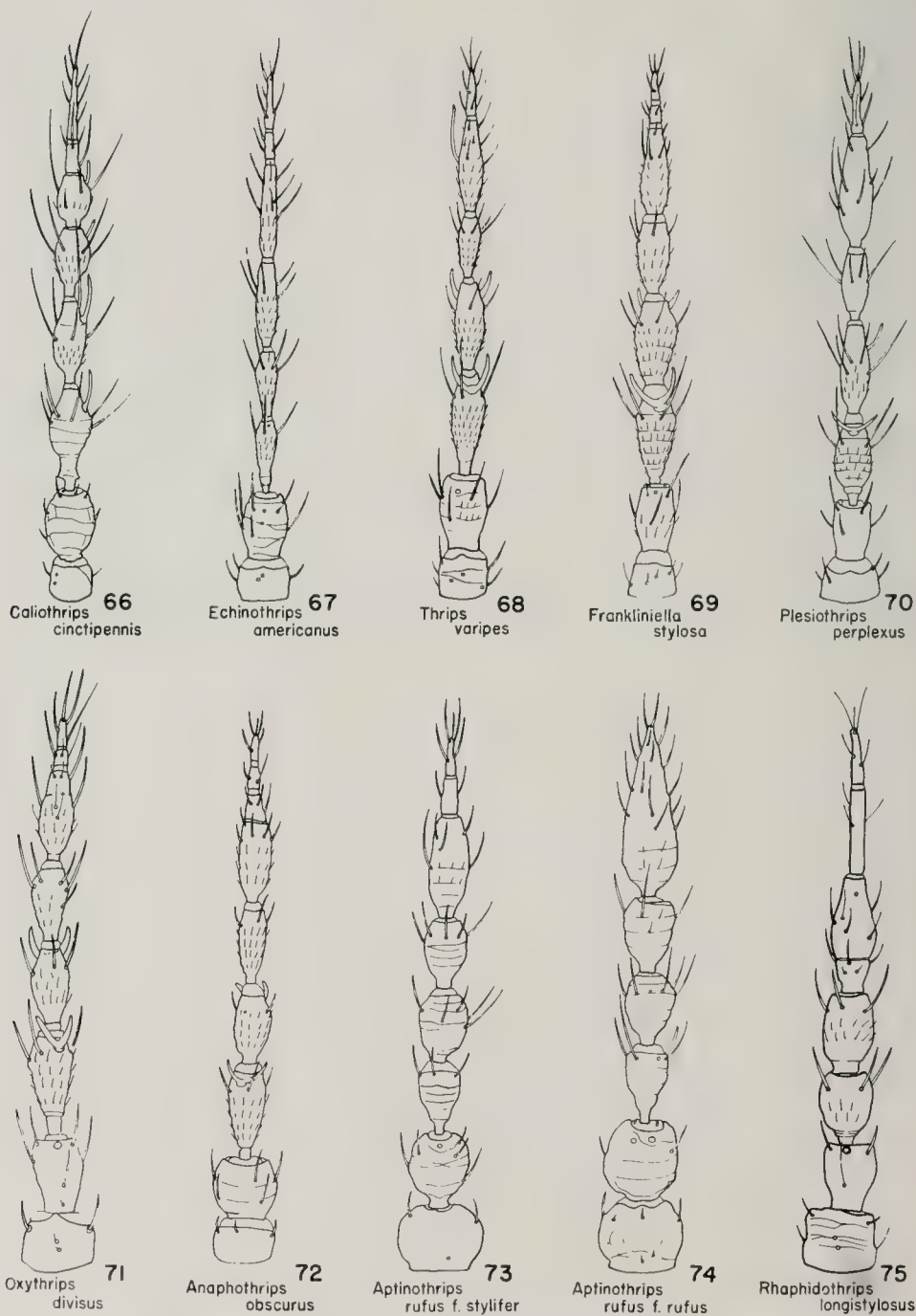


Fig. 66-75.—Right antenna, dorsal aspect, of species indicated, representatives of the Thripidae.

KEY TO
FAMILIES OF TEREBRANTIA
(ILLINOIS AND NEIGHBORING STATES)

- 1. Antennae nine segmented with sensoria of segments III and IV each placed longitudinally; fore wings broad and rounded at tips; ovipositor of female upturned. **Aeolothripidae**
Antennae six, seven, eight, or nine segmented with sensoria either protruding as forked or simple sense cones or as flat areas encircling apex of each of these segments; fore wings generally narrower and usually pointed at tips; ovipositor of female downturned. 2
- 2. Sensoria of antennal segments III and IV each protruding as a single or forked sense cone; cocoon-breaking hooks lacking on fore tarsi. **Thripidae**
Sensoria of antennal segments III and IV encircling apex of each segment, flat, not protruding as a cone; cocoon-breaking hooks present (Fig. 76-78) or absent (Fig. 79) on fore tarsi. 3
- 3. Light yellowish brown thrips; antennae each eight segmented, segments III and IV with apical sensorial areas as single, large sensoria (Fig. 64); ovipositor of female weakly developed. **Merothripidae**
Dark brown thrips; antennae each nine segmented, segments III and IV with circumpolar sensorial areas composed of numerous small circular sensoria (Fig. 65); ovipositor of female strongly developed. **Heterothripidae**

AEOLOTHRIPIDAE
Uzel (1895)

These primitive thrips may be distinguished from all others in Illinois by the combination of relatively broad wings (when present), upturned ovipositor of the female, nine-segmented antennae, and elongate oval or longitudinal sensoria on antennal segments III and IV. As do those in the Heterothripidae, members of this family bear cocoon-breaking hooks on the fore tarsi.

Only two genera occur in our state, *Aeolothrips* and *Stomatothrips*. About a half dozen more genera are found in the southern and western regions of North America, still other genera occur elsewhere in the world, and even some fossil representatives are known. Two genera from Africa, *Fauriella* and *Opisthothrips*, stand intermediate between this family and the next phylogenetically advanced family, the Heterothripidae. Another genus, *Erotido-*

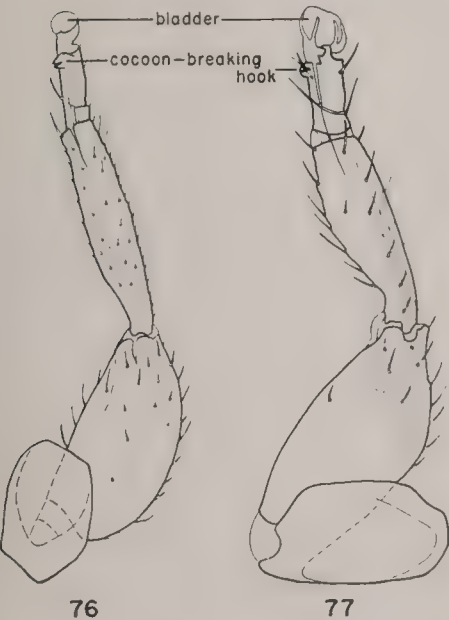


Fig. 76-77.—Right fore leg showing cocoon-breaking hooks: 76, *Aeolothrips melaleucus*; 77, *Heterothrips salicis*.

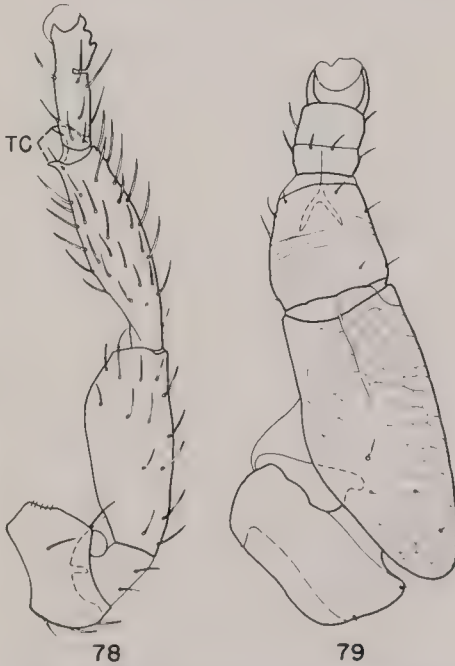


Fig. 78-79. Right fore leg showing presence or absence of tibial claws: 78, *Odontothrips pictipennis*; 79, *Chirothrips texanus*. TC—tibial claws.

thrips, from Asia and Africa, has intermediate characteristics between Aeolothripidae and Merothripidae.

KEY TO GENERA
(EASTERN UNITED STATES)

1. Maxillary palps eight segmented; antennal segments III and IV with narrow sensoria (Fig. 82).....*Stomatothrips*
Maxillary palps three segmented; antennal segments III and IV with wider sensoria (Fig. 62, 80, and 81).....2
2. Antennae with segment III greatly elongate (Fig. 80); sensoria of segments III and IV each extending almost entire length of its respective segment (Fig. 80 and 81); not yet found in Illinois.....*Franklinothrips*
Antennae with segment III shorter (Fig. 62); sensoria of segments III and IV each confined to the apical half of its respective segment (Fig. 62).....*Aeolothrips*

Aeolothrips Haliday

Aeolothrips Haliday (1836:451). Type-species by monotypy.—*Aeolothrips* (*Aeolothrips*) *albicincta* Haliday. Valid designation according to International Code of Zoological Nomenclature, Article 61 (a) (1961).

Aeolothrips subgenus *Coleothrips* Haliday (1836:451). Type-species by subsequent designation by Westwood (1839).—*Thrips fasciata* Linnaeus. Raised to full generic rank by Amyot and Serville (1843). Synonymized by implication by Uzel (1895).

Head about as wide as or wider than long. Ocelli present. Eyes prolonged ventrally. Antennae eight segmented, terminal segments closely joined, segments III and IV elongate, segments usually more elongate in male than in female. Sensoria on antennal segments III and IV oval to linear, not subdivided as is the case in *Stomatothrips*. Maxillary palps three segmented, labial palps four segmented.

Pronotum without any long setae. Mesospinasternum separated from metascutum by a complete suture. All tarsi two segmented. Fore tarsi each with cocoon-breaking hooks. Macrop-terous or brachypterous. Fore wings broad, not expanded at apex, with two complete longitudinal veins and several crossveins, fringe cilia straight.

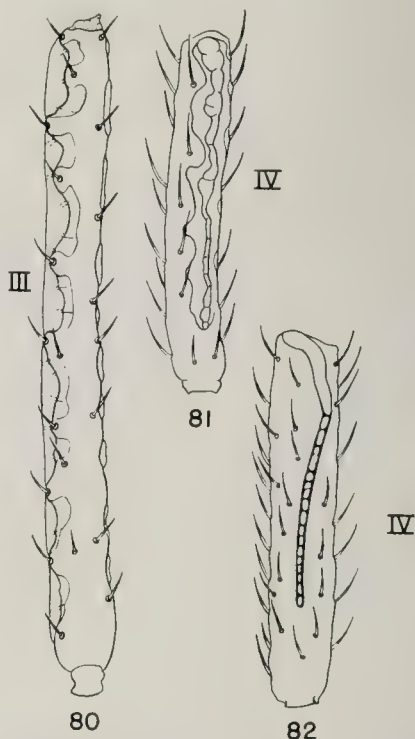


Fig. 80-82.—Antennal segments III or IV as indicated: 80, *Franklinothrips vespiformis*, ♂; 81, *Franklinothrips vespiformis*, ♀; 82, *Stomatothrips crawfordi*, ♀.

Abdomen constricted at base. Abdominal tergites with median pair of setae placed far apart. Abdominal sternites with a few accessory setae at sides. Abdominal tergite VIII without a posterior comb of setae. Females with well-developed, upturned ovipositor. Males with abdominal tergite I usually bearing two longitudinal ridges, without sternal glandular areas, and with or without genital claspers.

Sexual dimorphism is particularly noticeable in the comparative lengths of the antennal segments and sometimes in color in the species in which both males and females are known. The species whose life histories have been studied have two larval instars and two pupal instars. Prior to pupation a cocoon is spun, usually in cracks in the ground. Apparently all species, as larvae and as adults, are primarily predacious on other insects. Some at

least, also may feed on plants occasionally.

Eight of the 35 or so species and subspecies recorded from North America occur in Illinois. These eight can be categorized conveniently into the following three groups based on the color pattern of the fore wings of the females.

The **fasciatus** group (*fasciatus*, *albicinctus*, *bicolor* and *nasturtii*): These species have two separate, complete, dark crossbands on each fore wing except in the short-wing forms of *albicinctus*, the only species of *Aeolothrips* in Illinois which is brachypterous. The species *bicolor* and *nasturtii* can be separated further from the other two by the comparative length of antennal segment VI. In both *bicolor* and *nasturtii*, antennal segment VI is long, more than half as long as segment V; whereas in *fasciatus* and *albicinctus*, antennal segment VI is shorter, much less than half as long as segment V.

The **vittatus** group (*vittatus*, *vittipennis*, and *crassus*): In this group each fore wing is darkly banded along the trailing margin. Sometimes a single, partial or complete, crossband is connected to this dark margin.

The **melaleucus** group (*melaleucus*): The sole Illinois representative has two complete, dark crossbands which are connected along the trailing edge of the fore wing.

Possibly four of the species, *fasciatus*, *albicinctus*, *vittatus*, and *melaleucus*, were introduced from Europe. Almost certainly the other four are indigenous. All those in the **fasciatus** group are dwellers of the open fields. Those in the **vittatus** and **melaleucus** groups occur in woodlands.

Bailey (1951) presented a key to the North American species and Priesner (1948) published a key to the European and North African species.

KEY TO SPECIES

- 1. Brachypterous (brachypterous form of *fasciatus* not yet found in Illinois and unavailable to me for study)..... a form of *albicinctus* Macropterous.....2
- 2. Females.....3
- Males (males of *crassus*, *hartleyi*, *melaleucus*, *nasturtii*, *versicolor*, and *vittatus* are still unknown).....12

- 3. Fore wing with two completely separated, darkly colored, crossbands (Fig. 83) . . . 4
- Fore wing with one crossband, with two connected crossbands, or with only a longitudinal posterior band. 7
- 4. Antennal segment VI longer than half the length of segment V 5
- Antennal segment VI shorter than half the length of segment V 6
- 5. Abdominal segments II and III light in color in sharp contrast to rest of abdomen *bicolor*
- All abdominal segments dark in color *nasturtii*
- 6. Antennal segment V longer than the apical four segments collectively; abdominal segments II and III pale in color *albicinctus*
- Antennal segment V about equal to or shorter than the apical four segments collectively; abdominal segments dark in color *fasciatus*
- 7. Fore wing with two dark crossbands connected along the posterior margin (Fig. 84) *melaleucus*
- Fore wing with a dark posterior band, with or without a single, partial, or complete crossband 8
- 8. Base of sense cone on dorsum of antennal segment V linear; basal part of posterior band on fore wing continued to include scale (Fig. 85) *vittipennis*
- Base of sense cone on dorsum of antennal segment V round or oval; basal part of posterior band on fore wing not continued to include scale 9
- 9. Fore wing without a complete crossband arising from the posterior band (Fig. 86) *crassus*
- Fore wing with a complete crossband arising from the posterior band 10
- 10. Antennal segment IV brown; from western states and New York; not yet found in Illinois *hartleyi*
- Antennal segment IV predominantly yellow 11
- 11. Fore wing with brown crossband occupying most of median region; anterior portion of tibiae and all tarsi yellow; from Europe and New York, not yet found in Illinois *versicolor*
- Fore wing with brown crossband smaller; legs brown *vittatus*
- 12. Lateral margins of abdominal segment IX having bifid clasper-like processes (Fig. 87); fore wing with two separated, complete crossbands 13
- Lateral margins of abdominal segment IX without such processes; fore wing with only one crossband arising from posterior longitudinal band . *vittipennis*
- 13. Abdominal tergites IV and V, at the least, each with a pair of posterolateral truncate projections; antennal segment VI about equal to segments VII-IX combined *fasciatus*
- Abdominal tergites without such projections; antennal segment VI much longer than VII-IX combined . *bicolor*

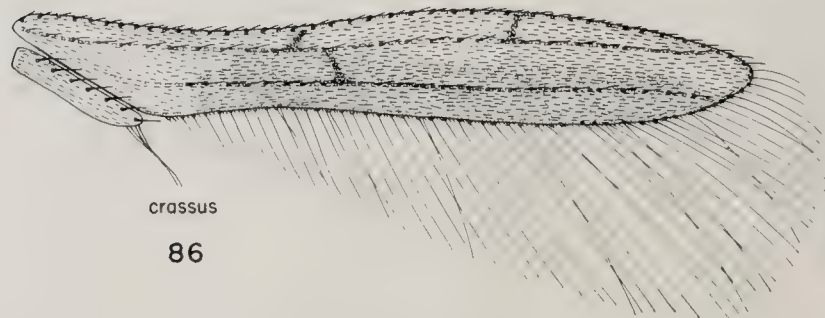
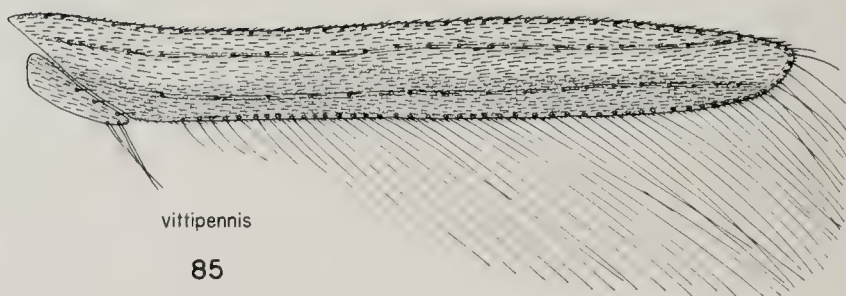
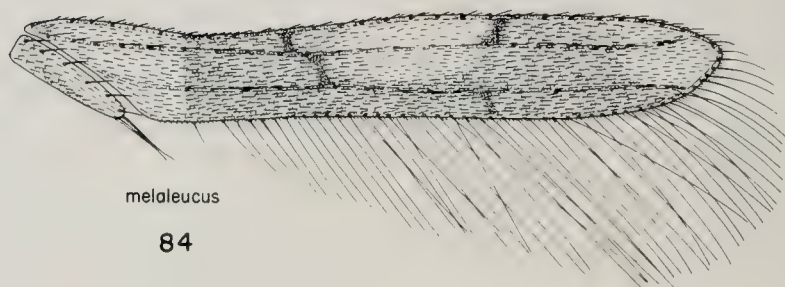
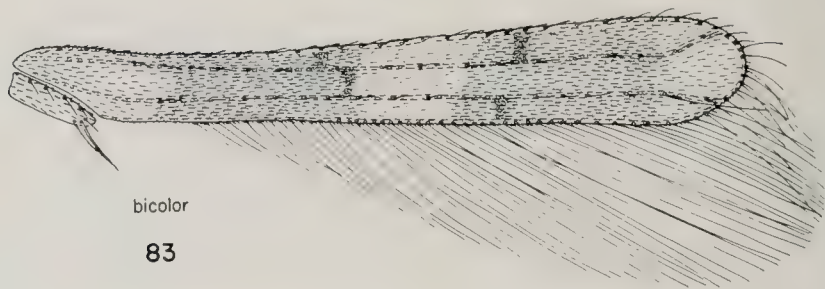


Fig. 83-84.—Right fore wing: 83, *Aeolothrips bicolor*; 84, *Aeolothrips melaleucus*.

Fig. 85-86.—Right fore wing: 85, *Aeolothrips vittipennis*; 86, *Aeolothrips crassus*.

Aeolothrips albicinctus Haliday

Aeolothrips albicincta Haliday (1836: 451). ♀. Type-locality.—England.

FEMALE (brachypterous).—Length distended nearly 2 mm. Bicolored dark brown and yellow. Dark brown: head, antennal segments IV–IX, prothorax, metathorax, abdominal segment I, abdominal segments IV–IX inclusive, and legs. Yellow: antennal segments II and III except extreme apex, sides of mesothorax, abdominal segments II and III except thin median anterior line, and abdominal segment X. Light brown: antennal segment I and median portion of mesothorax. Subintegumental pigment red.

Antennae moderately elongate, last four segments each small. Head weakly striate; abdominal segment I finely and closely transversely striate.

FEMALE (macropterous).—Similar in structure and color to brachypterous female except mesothorax darker along sides. Fore wings each with two separate, complete, dark crossbands.

MALE (brachypterous).—Length distended nearly 1.5 mm. Colored much as in female except somewhat lighter and antennal segment III brownish in the apical half. Intermediate antennal segments longer than in female. Abdominal tergite I not transversely striate but with two heavy, longitudinal streaks. Abdominal segment IX without claspers. Abdominal segments without dorsal truncate posterior projections. As far as is known males are always brachypterous.

Only the wingless (brachypterous) form of this species has been taken in Illinois. Fully winged individuals have been found to occur in New York (Hood 1915b) and Europe.

A. albicinctus was first reported in North America by Hood in 1915 and undoubtedly is a European introduction. Apparently it has not extended its range farther west than Iowa. It is common in the northern half of Illinois in disturbed, nonforested sections such as roadsides, pastures, and cultivated fields where it seeks its prey.

In structure this species is most distinctive. The close striations of abdominal tergite I of the female, and the brachypterous condition of both sexes permit easy recognition of *albicinctus* in the Illinois fauna. In other respects, bicolored yellow and brown and living in open fields, it resembles *bicolor*. Perhaps *albicinctus* was originally the European equivalent of our native *bicolor*.

Illinois records.—Collected from April through August, from one to several localities in the following counties: BUREAU, COOK, DE WITT, DOUGLAS, EDGAR, IROQUOIS, KANKAKEE, MCLEAN, MERCER, MORGAN, PUTNAM, ROCK ISLAND, STEPHENSON, WINNEBAGO, and WOODFORD.

Aeolothrips bicolor Hinds

Aeolothrips bicolor Hinds (1902:130). ♀, ♂. Type-locality.—Amherst, Massachusetts.

FEMALE (macropterous).—Length distended over 2 mm. Bicolored brown and pale yellow with much red subintegumental pigment. Dark brown: head, antennae except basal seven-eighths of segment III, thorax, legs, and abdomen except segments II and III. Light yellow: antennal segment III except for brown ring at apex and abdominal segments II and III. Fore wings each with two separated, dark crossbands (Fig. 83).

Head weakly striate. Antennal segment VI decidedly more than half as long as segment V.

Abdominal segment I not closely nor strongly striate.

MALE (macropterous).—Length distended nearly 1.5 mm. General color lighter than female, that is, areas which are brown in female are yellowish brown in male, antennal segment III becoming yellowish brown in apical half. Abdominal segments II–IV nearly colorless.

Antennal segments VI and VII more elongate than in female.

Abdominal tergite I with two submedian, longitudinal ridges. Abdominal tergites without truncate posterior projections. Abdominal tergite IX

with well-developed genital claspers (Fig. 87).

In color this species is much like the introduced *albicinctus* but in structure it is more like *nasturtii*. Both *nasturtii* and *bicolor* have antennal segment VI elongated, a condition which sets them apart from their congeners in Illinois. The male of *bicolor* has antennal segments VI and VII considerably elongated. Unfortunately, no males of *nasturtii* are known and comparisons cannot be made with *bicolor* in this sex.

Outside of Illinois the western *brunneipictus* is even more closely related to *bicolor*. Unlike *bicolor*, the typical *brunneipictus* has a pair of brown spots on abdominal tergites II and III which are otherwise yellow. In *bicolor*, abdominal tergites II and III are entirely yellow to nearly white. Possibly *bicolor* and *brunneipictus* intergrade in sections of western North America. According to Bailey (1951), the Floridian populations of *bicolor* differ somewhat from the typical form.

This native grassland species is one of the most common members of *Aeo-*

lothrips in our state. Although females are more abundant than males, males are by no means rare, at least not in Illinois. *Aeolothrips bicolor* still persists in the prairie remnants and has successfully invaded the European type pastures and roadsides cultivated in the past 100 years. Its total range includes most of temperate eastern North America, west to about the 100th meridian.

Illinois records.—Collected from April to October, from one to several localities in the following counties: ADAMS, BOND, BUREAU, CARROLL, CHAMPAIGN, CLARK, CLAY, COOK, DE WITT, DOUGLAS, EFFINGHAM, FAYETTE, GREENE, GRUNDY, HARDIN, IROQUOIS, JACKSON, JEFFERSON, JO DAVIESS, JOHNSON, KANKAKEE, LA SALLE, LAWRENCE, LEE, MADISON, MARION, MASON, MCHENRY, MERCER, MONROE, MORGAN, OGLE, PIATT, PIKE, POPE, PULASKI, RANDOLPH, ROCK ISLAND, SANGAMON, STARK, STEPHENSON, TAZEWELL, UNION, VERMILION, WABASH, WASHINGTON, WAYNE, and WOODFORD.

Aeolothrips crassus Hood

Aeolothrips crassus Hood (1912c:130).

♀. Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended about 1.8 mm. Body color dark brown with much red subintegumental pigment. Antennal segments III and IV yellow except for a narrow brown band at the apex of segment IV, rest of antennae brown. Fore wings each with a dark posterior band that does not reach the scale and which is thickened at the base as a rudimentary, incomplete crossband (Fig. 86).

Head weakly striate. Antennae relatively short and stout, each of the last four segments short. Abdominal tergites not closely nor strongly striate.

MALE.—Unknown.

Undoubtedly *crassus* is closely related to *vittatus*. They are best distinguished by the fore wing markings. The species *vittatus* has a single complete crossband arising from the posterior band on the fore wing, whereas

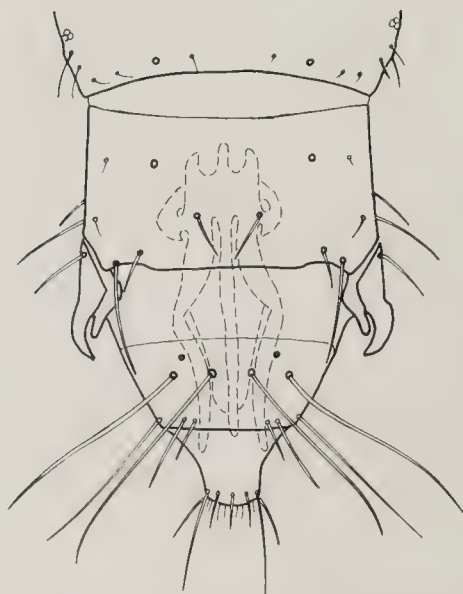


Fig. 87.—Terminalia of *Aeolothrips bicolor*, ♂, showing pair of clasper-like processes on abdominal tergite VIII.

crassus has only a rudimentary cross-band arising from this posterior band.

Originally recorded from Maryland (Hood 1912c) and later from Virginia (Bailey 1951), this rare species is now known for the first time to be in Illinois. In his description of *crassus*, Hood doubtfully listed a specimen of this species from Urbana, Illinois, but that specimen proved to be *vittatus* and not *crassus*. Our few authentic representatives of this species are from southern Illinois.

Illinois records.—GALLATIN COUNTY: Pounds Hollow Recreation Area, April 24, 1963, Evers, Stannard, vegetation in woods, 2 ♀. HARDIN COUNTY: Elizabethtown, May 4, 1950, Sanderson, Stannard, sweeping vegetation in woods, 1 ♀.

Aeolothrips fasciatus (Linneaus)

Thrips fasciata Linneaus (1758:457).

? ♀. Type-locality.—Not given, but undoubtedly in northern Europe.

Physapus fasciata (Linneaus). Transferred by Sulzer (1761).

Aeolothrips (Coleothrips) fasciata (Linneaus). Subgeneric assignment by Haliday (1836).

Coleothrips fasciata (Linneaus). Transferred by Amyot and Serville (1843).

Coleothrips trifasciata Fitch (1855a: 385). ? ♀. Type-locality.—Washington County, New York. Synonymized by Priesner (1926b).

Aeolothrips propinquus Bagnall (1924: 269). ♀. Type-locality.—Surrey, England. Synonymized by Priesner (1926b).

FEMALE (macropterous).—Length distended over 2 mm. General color blackish brown with much red subintegumental pigment. Antennal segment III yellowish, fading to brown at the apex. Fore wings each with two separate, complete, dark crossbands. Head weakly striate. Last four antennal segments small.

Abdominal tergite I not closely nor strongly striate.

MALE.—Length distended about 1.5 mm. Lighter in color than female, generally light brown. Antennal segments similar to female.

Abdominal tergite I elongate, with two longitudinal, submedian ridges. Abdominal tergites IV and V each with a pair of truncate lateral projections. Abdominal segment IX with a pair of bifid, lateral projections (Fig. 87).

Males have not yet been found in Illinois.

This species is one of the four species of thrips described by Linneaus in the 10th edition of *Systemae Naturae*. It can be distinguished from other species of *Aeolothrips* in Illinois by the combination of the wing colors, the small size of antennal segment VI, and the uniformly dark color.

By way of speculation, it may be that *fasciatus* s. str. was originally confined to the Palearctic realm. Close relatives of *fasciatus* in the Nearctic region occurred natively only in the western part of North America. Eventually man accidentally introduced the European form of the species complex into eastern North America where it has become established and widespread. In the northern half of Illinois, *fasciatus* is common in fields and along roadsides.

Illinois records.—Collected from May to September, from one to several localities in the following counties: CARROLL, CHAMPAIGN, COOK, DOUGLAS, DU PAGE, FULTON, HENDERSON, IROQUOIS, JO DAVIESS, KANE, KANKAKEE, LAKE, MCHENRY, MCLEAN, PIKE, PUTNAM, TAZEWELL, WAYNE, WILL, and WINNEBAGO.

Aeolothrips melaleucus Haliday

Aeolothrips melaleuca Haliday (1852: 1117). ♀. Type-locality.—England.

Aeolothrips fasciatus var. *coniunctus* Priesner (1914b:259). ♀. Type-locality.—Linz, Austria. Synonymized by Priesner (1926b).

Aeolothrips annectans Hood (1916d: 109). ♀. Type-locality.—Great Falls, Maryland. Synonymized by Priesner (1926b).

FEMALE (macropterous).—Length distended nearly 2 mm. Body color dark brown with much red subinteg-

umental pigment. Antennal segment III and dorsal part of antennal segment IV yellow, rest of antennae brown. Fore wings fully developed, each with two broad crossbands which are connected posteriorly by a dark band as in Fig. 84.

Head only faintly transversely striate. Antennal segments III and IV moderately elongate, last four segments short. Abdominal tergites not closely nor strongly striate.

MALE.—Unknown.

According to Priesner (1926b) Uzel misidentified *melaleucus* in his 1895 monograph. Priesner believes that Uzel's *melaleuca* represents but a form or subspecies of *Aeolothrips versicolor*. It would be better if this form or subspecies were called *Aeolothrips versicolor maculosus* Bagnall, the first available name, rather than, as is the prevailing custom, *Aeolothrips versicolor melaleucus* Uzel which is homonymous with the full species *Aeolothrips melaleucus* Haliday.

Hood has published records of *A. melaleucus* as being in North America at least since 1913. Undoubtedly it was introduced from Europe and has since spread throughout the United States and into parts of Canada (Bailey 1951). It occurs now over the entire state of Illinois but even so it is only locally abundant.

Illinois records.—Collected in spring and summer, from one to many localities in the following counties: CARROLL, COOK, GALLATIN, HARDIN, JERSEY, JO DAVIESS, PEORIA, POPE, PUTNAM, and UNION.

***Aeolothrips nasturtii* Jones**

Aeolothrips nasturtii Jones (1912:2).
♀. Type-locality.—San Jose, California.

Franklinothrips nasturtii (Jones).
Transferred by Bagnall (1913). Recombined with *Aeolothrips* by Hood (1915b).

Aeolothrips tuolumnei Moulton (1927b: 187). ♀. Type-locality.—Tuolumne County, California. Synonymized by Bailey (1949b).

FEMALE (macropterous).—Length distended slightly less than 2 mm. Body color dark brown with much red subintegumental pigment. Antennal segment III yellow except brown ring at the apex. Fore wing with two separate, complete, dark crossbands.

Head weakly striate. Antennal segment VI elongate, about half as long as segment V. Abdominal segment I not strongly cross striate.

MALE.—Unknown.

A. nasturtii is very similar to *bicolor*, but whereas *bicolor* has abdominal segments II and III light yellow, *nasturtii* has these segments brown.

Although undoubtedly a western species, *nasturtii* is occasionally found all the way to the East Coast. Possibly this species has been or is still being introduced by man into the eastern states including Illinois. So far *nasturtii* has been taken only twice within the borders of our state.

Illinois records.—COOK COUNTY: West Chicago, August 5, 1959, Evers, Mockford, Stannard, prairie grasses, 5 ♀. MCHENRY COUNTY: Algonquin, July 2, 1913, sweeping on Jayne Hill, 1 ♀.

***Aeolothrips vittatus* Haliday**

Aeolothrips (Coleothrips) vittata Haliday (1836:451). ♀. Type-locality.—England.

Aeolothrips limbata Reuter (1879:222). ? ♀. Type-locality.—Finland. Synonymized by Priesner (1926b).

FEMALE (macropterous).—Length distended about 1.8 mm. Body color dark brown with much red subintegumental pigment; antennal segments III and IV yellow except for a narrow brown band at the apexes, rest of antenna brown; fore wings with a dark posterior band that does not reach the scale and which is thickened at the base into a complete crossband.

Head faintly striate. Antenna short and stout, last four segments each short (Fig. 62). Abdominal tergite I not closely nor strongly striate.

MALE.—Unknown.

This species is similar to *crassus* and *hartleyi*. It differs from *crassus* in that the crossband of the fore wing is complete and touches the fore margin, and from *hartleyi* in that antennal segment IV is almost entirely yellow instead of predominantly brown.

Apparently *vittatus* prefers to hunt its prey in conifer trees. Although possibly introduced from Europe, it was first taken in Illinois as early as 1908 as doubtfully included by Hood (1912c) under the name *crassus*. That specimen was found on a conifer in Urbana, an area which never contained any native coniferous trees, not even red cedar (*Juniperinus*). Lately it has been found near Chicago on introduced jack pine and at Oquawka around pine plantations. Bailey (1951) also lists this species in North America from New Jersey, New York, and Ontario. It has been recorded from many places in Europe.

Illinois records.—CHAMPAIGN COUNTY: Urbana, May 21, 1908, Bopp, on conifer, 1 ♀ (reported by Hood in 1912). COOK COUNTY: Thornton, June 22, 1949, Ross, Stannard, sweeping planted jack pine, 2 ♀. HENDERSON COUNTY: Oquawka, May 9, 1952, Stannard, sweeping near pine plantations, 1 ♀.

Aeolothrips vittipennis Hood

Aeolothrips vittipennis Hood (1912c: 129). ♀, ♂. Type-locality.—Toupeka, Illinois.

Aeolothrips floridensis Watson (1916: 126). ♀. Type-locality.—Gainesville, Florida. Synonymized by Bailey (1951).

FEMALE (macropterous) (Fig. 88).—Length distended about 2 mm. Body dark brown with much red subintegumental pigment. Antennal segment III yellow except for brown ring at apex; segment IV yellow in basal half, brown in apical half; segment V generally brown but slightly yellowish brown basally; rest of antennal segments brown. Fore wings with a dark band in the posterior half which extends from the base, including the

scale, to the tip of the wing (Fig. 85); rarely with crossband (Bailey 1951).

Head closely and distinctly transversely striate. Antennae fairly short, segment V decidedly smaller than IV, terminal four segments short. Base of sense cone on antennal segment V unusually elongate, definitely linear instead of round or oval.

Abdominal tergite I not closely or strongly striate.

MALE (macropterous).—Length distended about 1.5 mm. Colored much as in female except lighter brown in the intermediate abdominal segments. Fore wings with a brown posterior band as in female but always with a complete crossband arising from the posterior band about in the middle of the wing.

Antennal segment V just slightly smaller to about equal in length to segment IV.

Abdominal tergite I without two longitudinal ridges. Abdominal segment IX without genital claspers. Abdominal tergites without dorsal truncate posterior projections.

Males of this species differ markedly from the females in the length of antennal segment V and in the coloration of the fore wings. Both sexes exhibit an extensive brown posterior band on the fore wing, including the scale, and by this characteristic *vittipennis* may be distinguished from other Illinois species. Other species in Illinois which have posterior wing bands, *crassus* and *vittatus*, have the scale predominantly colorless. Also the head of *vittipennis* is more distinctly striate than in either *crassus* or *vittatus*.

Aeolothrips vittipennis is locally common in Illinois, on locust trees (*Gleditsia* and *Robinia*) in association with *Sericothrips annulipes*, upon which it may prey. Typical populations are known from the District of Columbia, Florida, Illinois, New Jersey, North Carolina (INHS records), and Tennessee. Related populations in the West and Southwest have been accorded a subspecific rank by Bailey (1951).

Illinois records.—Collected during

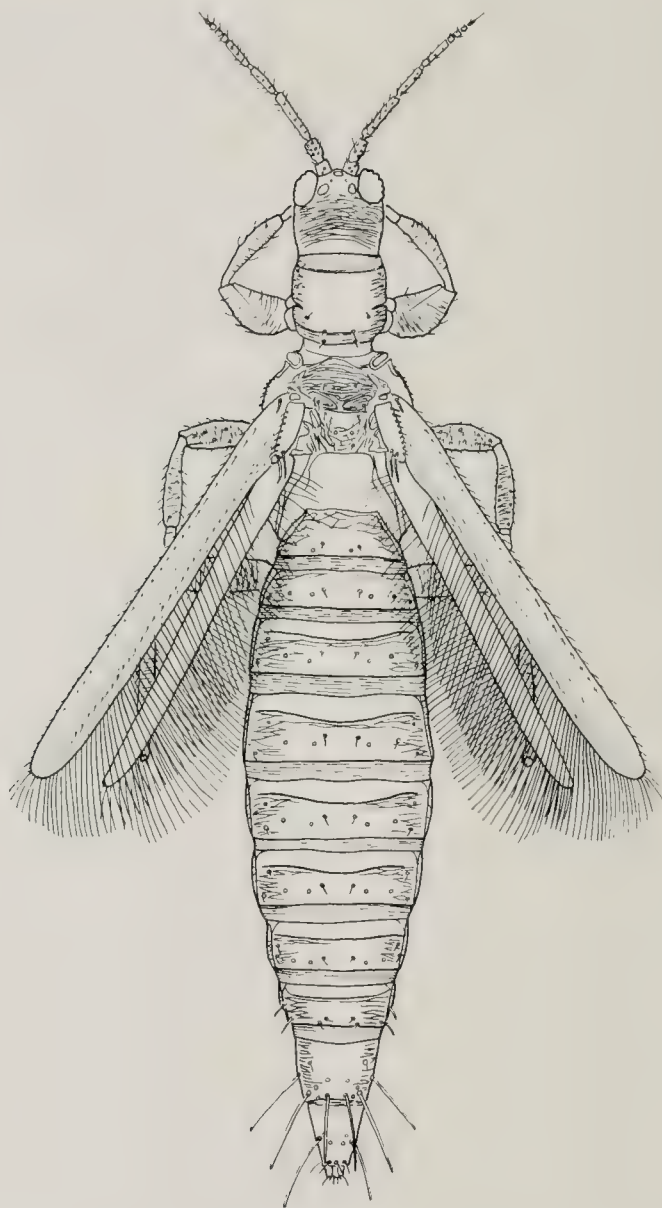


Fig. 88.—*Aeolothrips vittipennis*, dorsal aspect.

the spring and summer, from one to several localities in the following counties: CHRISTIAN, CLINTON, COOK, GREENE, HANCOCK, HARDIN, JACKSON, JERSEY, JO DAVIESS, MARION, PIKE, PULASKI, SANGAMON, STEPHENSON, UNION, and VERMILION.

Stomatothrips Hood

Stomatothrips Hood (1912a:63). Type-species by original designation.—*Stomatothrips flavus* Hood.

Head about as wide as long, only slightly prolonged beyond eyes. Ocelli

present, widely spaced. Eyes not prolonged or only slightly prolonged ventrally. Antennae nine segmented, terminal segments closely joined, intermediate segments elongate, segments more elongate in male than in female. Sensoria on antennal segments III and IV linear and much subdivided, similar, in a lesser degree, to those found in *Franklinothrips*. Maxillary palps seven or eight segmented, labial palps five segmented.

Prothorax setose but without any long setae. Mesospinasternum well separated from metascutum by a complete suture. All tarsi two segmented. Fore tarsi each with cocoon-breaking hooks. Macropterous or micropterous. Fore wings moderately broad, expanded at apex, with two complete longitudinal veins and several cross-veins, fringe cilia straight.

Abdomen constricted at base. Abdominal tergites with median pair of setae placed well apart. Abdominal sternites with accessory setae. Abdominal tergite VIII without a posterior comb of setae. Female with well-developed, upturned ovipositor. Males with abdominal tergite I bearing two longitudinal ridges, without sternal glandular areas, and without genital claspers. Eggs obliquely truncate at anterior end.

This genus is easily distinguished from all others in Illinois by the eight-segmented maxillary palps.

According to Bailey (1952), who reviewed and keyed the species, members of *Stomatothrips* are probably predacious and presumably spin pupal cocoons.

Generally this is a group of the New World tropics and warm-temperate zones. The new species *crawfordi*, however, ranges into Illinois.

***Stomatothrips crawfordi* new species**

FEMALE (micropterous) (Fig. 89).—Length distended over 2 mm. General color yellowish tan and brown. Brown: head, prothorax, parts of pterothorax, mid and hind tarsi, and terminal segments of antennae. Abdominal seg-

ments II and X largely yellow. Antennal segments I and II yellow to light yellowish tan, segment III pale, segment IV pale except apex which is brown, and segments V–IX brown. Ocellar pigment red. Fore wings with two separated, broad, brown cross-bands on the intermediate part of the fore wing, and with the apex and extreme base brown.

Antennae (Fig. 63 and 82) with segment VII $2\frac{1}{2}$ times as long as VIII. Maxillary palps eight segmented.

Abdominal tergite IX with major setae all equally long.

FEMALE (macropterous).—Similar to micropterous form except wings longer.

MALE (macropterous).—Length distended about 1.5 mm. Similar to female with the following exceptions. Generally lighter in color. Antennal segments I–IX brown except base of segment III with a pale ring above pedicel. Antennal segments, especially subterminal segments, proportionately longer than in female. Abdominal tergite IX with median pair of setae much shorter than other major setae.

Holotype.—Female, Gorham (Fountain Bluff), Jackson County, Illinois, August 16, 1950, Stannard, sweeping *Andropogon* on hill prairie. **Allotype**.—Male, same data as for holotype. **Paratypes**.—4 ♀, 1 ♂, same data as for holotype. Types deposited in the collections of the Illinois Natural History Survey, Urbana. Additional specimens have been collected in Illinois in summer, from one to several localities in the following counties: Greene, Hardin, Iroquois, Jasper, Marion (USNM), Ogle, Pike, Pulaski, Vermilion, and Washington (USNM).

As suspected by Bailey (1952), Hood's original material, now available at the U.S. National Museum, turns out to be a mixture of two species. The holotype of *flavus*, from Monterrey, Mexico, differs from the Illinois species, described herein, by having antennal segment VII only twice as long as segment VIII, antennal segments III and IV slightly shorter, the fore wings somewhat broader at the

widest portion, the hind tibiae shorter, and the mesoscutum with more setae. The species *brunneus* from Arkansas is much like *flavus* in many characteristics, and, indeed, both latter names may represent the same species.

The new species described here is named in honor of the late James C. Crawford who was a master of the Thysanoptera and freely shared his knowledge with all students who sought his assistance.

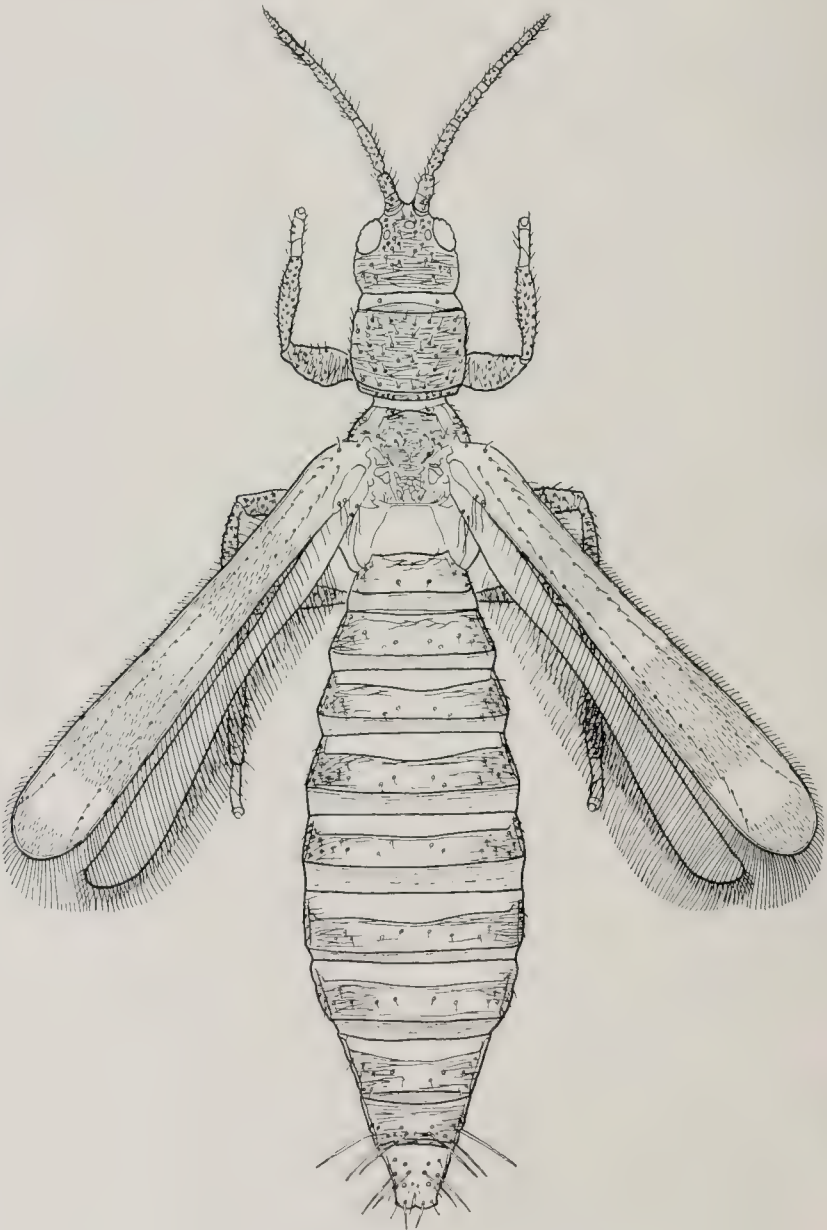


Fig. 89.—*Stomatothrips crawfordi*, dorsal aspect.

HETEROTHIRIPIDAE Bagnall

(1912b)

As concerns the Illinois fauna only, this family may be characterized by the feature of the circumpolar rings on antennal segments III and IV which are composed of small circular sensoria (Fig. 65).

The genus *Heterothrips* alone represents the family in eastern North America. Another North American genus, *Oligothrips*, with quite different antennal sensorial characteristics, occurs in California.

Heterothrips Hood

Heterothrips Hood (1908c:361) (*nec* Buffa 1908). Type-species by monotypy.—*Heterothrips arisaemae* Hood.

Phyllothrips Buffa (1908:123) (*nec* Hood 1908a). Type-species by monotypy.—*Phyllothrips pilosus* Buffa. Synonymized by Bagnall (1911a).

Phyllothripsiolus Strand (1911:287). New name for *Phyllothrips* Buffa, preoccupied. Synonymized by Hood (1913a).

Head wider than long. Ocelli present, fore ocellus small. Antennae nine segmented, segment III with two white subbasal bands giving that segment the appearance of having a two-jointed petiole, segments III and IV each with a circumpolar ring composed of circular sensoria. Maxillary palps three segmented. Labial palps two segmented.

Prothorax with short bristles only. Mesospinasternum separated from metasternum by a wide suture. Metascutum with striae in the form of concentric rings. All tarsi two segmented, fore tarsi each with cocoon-breaking spurs, fore femora enlarged. Fore wings enlarged at base, narrowed in apical three-fourths, with two longitudinal veins uniformly set with setae; nearly all wing fringe cilia straight, rarely wavy.

Abdomen without differentiated pleural plates; usually with most regions covered by microsetae; and posterior margins of the segments ex-

tensively fringed by setae, which in the intermediate tergites are often coalesced at base into plates. Median pair of tergal setae placed close together on the intermediate segments. Males often with abdominal sternal glandular areas and sometimes with finger-like projections on abdominal tergite IX. Females with downturned ovipositor.

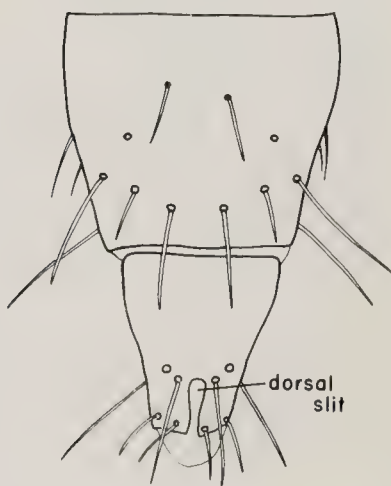
This genus nicely connects the more primitive thrips, the Aeolothripidae, with the advanced Thripidae. The nine-segmented antenna and cocoon-breaking spurs are also qualities of the Aeolothripidae, and the reduced narrow wings and downward curved ovipositors are features shared in common with the Thripidae. The combination of these generalized and specialized characteristics makes it easy to recognize the members of *Heterothrips*.

Bailey and Cott (1955) reviewed the genus for North America. They listed 21 species for North America and a total of slightly over 40 for the New World, the area to which this genus seems confined. A third of the North American species listed by these authors have been found in Illinois, and it is expected that several more will be found in future searches.

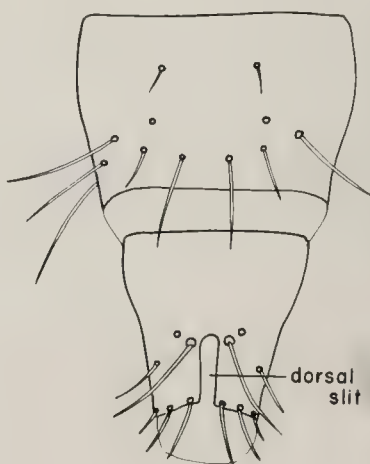
KEY TO SPECIES
(ILLINOIS AND NEARBY AREAS)

1. Females, with sawlike ovipositor. 2
Males, without ovipositor. 10
2. Intermediate abdominal tergites with posterior lateral comb setae each strongly fused to several other setae at the base. 3
Intermediate abdominal tergites with posterior lateral comb setae each independent and free or only barely fused to other setae at base. 7
3. Abdominal tergites II–VIII each with a complete row of posterior setae. *limbatus*
Abdominal tergites II–V, at the least, each with the posterior row of setae interrupted in the median region. . . . 4
4. Antennal segments III and IV exceptionally wide (segment III about twice as wide as segment V at their greatest width), with broad sensorial rings, each ring formed by a double row of sensoria (Fig. 65); in flowers of jack-in-the-pulpit and green dragon. . . . *arisaemae*
Antennal segments III and IV narrower

- (segment III less than or not much greater than $1\frac{1}{2}$ times as wide as segment V at their greatest width), with smaller sensorial rings, each ring formed by a row or $1\frac{1}{2}$ rows of staggered sensoria; in other flowers. 5
5. Abdominal tergites, along lateral margins, with numerous, closely set microsetae, and with fringe of comb plates generally longer than length of base; on flowers of azalea. *azaleae*
Abdominal tergites, along lateral margins, with fewer microsetae, and with fringe of comb plates generally shorter than length of base (Fig. 93), on other flowers. 6
6. Abdominal tergites II-V with median group of posterior setae well developed, often fused at base; on male catkins of *Salix interior*. *salicis*
Abdominal tergites II-V with median group of posterior setae sparse, never fused at base; on flowers of buckeye. *aesculi*
7. Fore wings entirely brown; abdominal tergite X long, basal portion to dorsal slit twice the length of the dorsal slit (Fig. 90); occurring on host in late summer. *auranticornis*
Fore wings off-white subbasally, brown in remaining portions; abdominal tergite X shorter, basal portion to dorsal slit hardly more than $1\frac{1}{2}$ times the length of the dorsal slit (Fig. 91); occurring on host in spring. 8
8. Abdominal tergites II-V with posterior lateral comb setae, especially extreme lateral ones, slightly fused at base to other setae; mesoscutal striations spaced well apart. *quercicola*
Abdominal tergites II-V with all posterior lateral comb setae independent and never even slightly fused to other setae; mesoscutal striations spaced close together. 9
9. Pronotal striae conspicuous, placed nearly as close together as striae of mesoscutum; on buds of wild grapes. *vitis*
Pronotal striae weak, not placed as close together as striae of mesoscutum; on flowers of wild roses. *analis*
10. Abdominal tergite IX with a pair of finger-like projections. 11
Abdominal tergite IX without a pair of finger-like projections. 12
11. Pronotal striae conspicuous, placed nearly as close together as striae of mesoscutum; on buds of wild grapes. *vitis*
Pronotal striae weak, not placed as close together as striae of mesoscutum; on flowers of wild roses. *analis*
12. Brachypterous; in flowers of several species of *Ariseama*. *ariseamae*
Macropterous. 13
13. Abdominal sternites without glandular areas; on flowers of buckeye. *aesculi*
Abdominal sternites III-VIII or IV-VIII each with a glandular area. 14
14. Abdominal glandular areas on sternites III-VIII. 15
Abdominal glandular areas on sternites IV-VIII only. 17
15. Fore wings uniformly brown; abdominal tergites with all posterior lateral setae independent and not fused to other setae; occurring on host in late summer. *auranticornis*
Fore wings each with a subbasal off-white spot; intermediate abdominal tergites with posterior lateral setae fused at base to other setae; occurring on host in spring. 16
16. Intermediate abdominal tergites with middle patch of setae well developed and generally fused together at base; on willow catkins. *salicis*



90



91

Fig. 90-91.—Abdominal terminalia, ♀, showing dorsal slit on tergite X of: 90, *Heterothrips auranticornis*; 91, *Heterothrips quercicola*.

Intermediate abdominal tergites with setae of middle patch, when present, widely spaced and not fused at base; on azalea. **azaleae**

17. Abdominal tergites II-V with a complete row of posterior fringe setae. **limbatus**
Abdominal tergites II-V with row of posterior fringe setae interrupted medially. **quercicola**

Heterothrips aesculi Watson
Buckeye Thrips

Heterothrips aesculi Watson (1915:50).
♀, ♂. Type-locality.—Gainesville, Florida.

FEMALE (macropterous).—Length distended nearly 1.5 mm. Color dark brown except antennal segment III and most of IV which are yellow to yellowish brown, apex of each fore tibia and all tarsi which are yellowish brown, and subbasal region of fore wings and all of hind wings (except longitudinal median streak) which are off-white.

Antennal segments III and IV each with a circumpolar sensory area composed of a staggered single row of small circular sensoria. Reticulations on prothorax weak, usually in the form of hexagonal designs. Posterior lateral margins of abdominal tergites I-VII with setae fused at base into comb plates; median area on abdominal tergites I-V bare except for a middle patch of setae, these setae separate and not fused; abdominal sternites III-VII with accessory setae in addition to the posterior setae; microsetae on abdominal segments I-VII sparse dorsally but numerous ventrally.

MALE (macropterous).—Length distended over 1 mm. Colored as in female. General structure as in female except with numerous microsetae on lateral regions of the abdominal tergites and usually without accessory setae on abdominal sternites III-VII. Abdominal sternites without glandular areas. Abdominal tergite IX without finger-like projections (Fig. 92).

Apparently the buckeye thrips is confined in its range to southeastern U.S.A. Its northern limit up the Mississippi River valley is reached in the southwestern tip of Illinois. In Illinois this thrips has never been taken outside the bottomlands of Alexander and

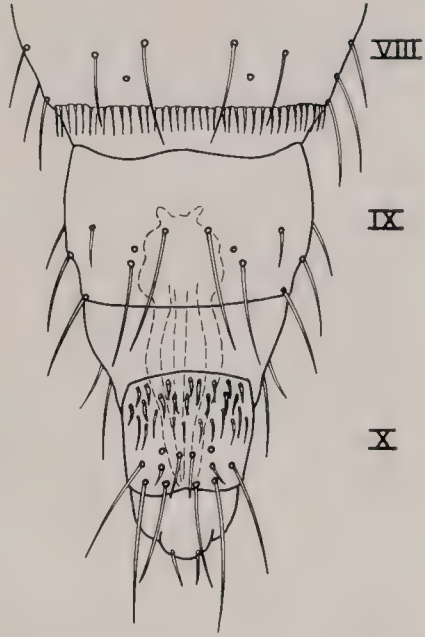


Fig. 92.—*Heterothrips aesculi*, ♂, abdominal terminalia.

Union counties. Within this area it is abundant on the flowers of several species of buckeye during the spring season.

Illinois records.—ALEXANDER COUNTY: Horseshoe Lake Refuge, April 8, 1954, Stannard, on *Aesculus pavia*, many females and males. UNION COUNTY: Wolf Lake, April 8, 1953, Stannard, on *Aesculus glabra*, many females and males; Wolf Lake, April 30, 1953, Stannard, on *Aesculus* species, 2 ♀; Jonesboro, May 12, 1932, Dozier, on *Aesculus pavia*, 12 ♀.

Heterothrips analis Hood
Wild Rose Thrips

Heterothrips analis Hood (1915a:9).
♀, ♂. Type-locality.—Plum Point, Maryland.

FEMALE (macropterous).—Length distended slightly over 1.2 mm. Color dark brown except antennal segments III and IV which are yellow to yellowish brown, apex of each fore tibia and all tarsi which are yellow, and subbasal region of fore wings and, except for the longitudinal median streak, all of the hind wings which are off-white.

Antennal segments III and IV with a circumpolar ring composed of a single staggered row of small circular sensoria. Reticulations on prothorax weak, fairly closely spaced but not as close as those striae on mesoscutum. Posterior lateral margins of abdominal tergites I–VIII with setae separate, not fused to other setae at base; median areas on abdominal tergites I–V and often VI bare except for a middle patch of setae, these setae also separate, not fused; abdominal sternites usually with accessory setae in addition to the posterior setae; microsetae numerous and generally disposed over the abdomen except for the bare median dorsal region of segments I–VII.

MALE (macropterous).—Length distended less than 1 mm. Similar to female in color except for antennal segment IV which is nearly brown. Structure similar to female except dorsal posterior setal comb usually interrupted medially on abdominal segment VIII, and usually abdominal sternites with few to no accessory setae in addition to the posterior setae. Abdominal sternites without glandular areas. Abdominal tergite IX with two finger-like projections.

Like *vitis*, this species is comparatively small. It lives on the flowers of wild roses in eastern North America and is locally abundant in Illinois. The late Mr. Crawford once told me that in New Jersey he often had to search in many rose flowers before he would come across this thrips. In Illinois the same diligence on the part of the collector is sometimes necessary in order to locate the populations. Apparently this species has not yet dispersed to the area once covered by the Wisconsin ice sheets.

The Illinois specimens I have studied differ in many ways from the holotype collected in Maryland. Although our rose species may be conspecific with the type-series, it represents a distinctive strain. In general, in the Illinois form of *analisis*, antennal segment III is relatively short and wide, antennal segment V is mostly brown, and the fore wing is light near the scale. By contrast, in the Mary-

land form of *analisis*, antennal segment III is longer and narrower, antennal segment V is mostly yellow, and the fore wing is not as light in color near the scale.

Illinois records.—CLARK COUNTY: Clarksville (Rocky Branch), July 6, 1961, Stannard, wild rose flowers, 3 ♀. CUMBERLAND COUNTY: Woodbury, June 29, 1949, Smith, Stannard, wild rose flower, 1 ♀. GALLATIN COUNTY: Pounds Hollow Recreation Area, May 26, 1954, Smith, Moore, Stannard, wild rose flower, 1 ♂. HARDIN COUNTY: Rosiclare, May 26, 1954, Smith, Moore, Stannard, wild rose flowers, 6 ♀, 2 ♂. JACKSON COUNTY: Giant City State Park, May 25, 1954, Smith, Moore, Stannard, wild rose flowers, 10 ♀, 8 ♂. SANGAMON COUNTY: Riverton, June 7, 1949, Smith, Sanderson, Stannard, wild rose flower, 1 ♀. TAZEWELL COUNTY: Tremont, June 2, 1948, Stannard, wild rose flower, 1 ♂. WASHINGTON COUNTY: New Minden, June 4, 1957, Stannard, wild rose flowers, 3 ♀. WAYNE COUNTY: Zenith, June 1, 1966, Stannard, wild rose flowers, 2 ♀.

Heterothrips arisaemae Hood

Jack-in-the-pulpit Thrips

Heterothrips arisaemae Hood (1908c: 362). ♀, ♂. Type-locality.—Urbana, Illinois.

FEMALE (macropterous).—Length distended over 1.5 mm. Color dark brown (nearly black in life) except antennal segment III which is yellow to yellowish brown, apex and base of each anterior tibia and all tarsi which are yellow, and subbasal region of fore wings and all of hind wings (except longitudinal median streak) which are off-white.

Antennal segments III and IV each with a comparatively broad circumpolar sensory area composed of two full rows of small circular sensoria (Fig. 65). Reticulations on prothorax faint, spaced fairly far apart. Posterior lateral margins of abdominal tergites I–VII with setae fused at base into comb plates; median area on abdominal tergites I–V bare except for a

middle patch of setae, these setae separate, not fused; abdominal sternites usually without accessory setae in addition to the posterior setae; microsetae on abdominal segments I-VII sparse dorsally but numerous ventrally.

MALE (brachypterous).—Length distended slightly more than 1 mm. Similar in color and general structure to female except median patch of setae on abdominal tergites I-V often absent and comb on abdominal tergite VI incomplete. Fully winged males unknown. Abdominal sternites III-VIII each with a large anteromedian, oval, glandular area. Abdominal tergite IX without finger-like projections.

This species was the first known *Heterothrips*. It was discovered in the flowers of jack-in-the-pulpit growing in Brownfield Woods, formerly Augerville Woods, a 55-acre tract near Urbana which still exists in a near virgin state, preserved and protected by the University of Illinois. Descendants or relatives of the original type population of *arisaemae* continue to occur there.

Heterothrips arisaemae is a common species throughout Illinois and the eastern deciduous forest biome, living on flowers of several species of *Arisaema*. Bailey & Cott (1955) report that in the male the sensorial rings of antennal segments III and IV may be incomplete. Males taken in Illinois have complete antennal sensorial rings in every instance.

Illinois records.—Collected from late April to mid-June, from one to several localities in the following counties: ADAMS, ALEXANDER, BOND, BOONE, BUREAU, CARROLL, CHAMPAIGN, CLARK, CLINTON, COLES, COOK, CUMBERLAND, DE WITT, EDWARDS, EFFINGHAM, FAYETTE, FRANKLIN, FULTON, GALLATIN, HAMILTON, HANCOCK, HARDIN, HENRY, JACKSON, JASPER, JEFFERSON, JERSEY, JO DAVIESS, JOHNSON, KANKAKEE, LA SALLE, LAWRENCE, LEE, LOGAN, MCLEAN, McDONOUGH, MACON, MACOUPIN, MADISON, MARION, MARSHALL, MONROE, MONTGOMERY, MORGAN, MOULTRIE, PEORIA, PERRY, PIATT, POPE, PUTNAM, RANDOLPH,

RICHLAND, ROCK ISLAND, SALINE, ST. CLAIR, SCHUYLER, SHELBY, UNION, VERMILION, WASHINGTON, WAYNE, WHITE, WHITESIDE, and WILLIAMSON.

Heterothrips auranticornis Watson

Heterothrips auranticornis Watson (1922c:36). ♀, ♂. Type-locality.—Rabun County, Georgia.

FEMALE (macropterous).—Length not distended about 1.2 mm. Color generally dark brown except antennal segments III and IV which are yellowish brown, fore tibiae and all tarsi which are largely yellow, and hind wings (except median longitudinal streak) which are off-white. Fore wings uniformly dark brown.

Antennal segments III and IV each with a circumpolar ring composed of a double row of sensoria. Reticulations of prothorax fairly widely spaced, forming hexagonal designs. Abdominal segments with all posterior fringe setae separate, not fused. Abdominal tergites I-V bare medially except for a middle patch of setae, these setae separate and not fused. Abdominal tergite X as in Fig. 90.

MALE (macropterous).—Length 0.8 mm according to Watson (1922). Generally similar to female (Watson 1922c). Abdominal sternites III-VIII each with an anteromedian glandular area and abdominal tergite IX without finger-like projections (Bailey & Cott 1955).

This thrips was first found in Illinois in 1957 by Dr. John M. Kingsolver. Since then it has been taken in many places in Illinois, mostly the northern part, in late summer. It has extensive distributional limits from Georgia to Utah (Bailey & Cott 1955). Although not known in many of the intervening states its absence in collections may be due entirely to insufficient sampling.

Illinois records.—Collected in August and September, from one to several localities in the following counties: ADAMS, BOND, CHAMPAIGN, DE KALB, DE WITT, EDGAR, FORD, FRANKLIN, FULTON, GRUNDY, HANCOCK, HENDERSON, HENRY, IROQUOIS, JO

DAVIESS, KANKAKEE, KNOX, LA SALLE, LEE, LIVINGSTON, LOGAN, MCLEAN, MERCER, PIKE, PUTNAM, SANGAMON, STARK, TAZEWEILL, WHITESIDE, and WILL.

Heterothrips azaleae Hood

Azalea Thrips

Heterothrips azaleae Hood (1916d:110).

♀. Type-locality.—Beltsville, Maryland. Bailey & Cott (1955: 622). ♂.

FEMALE (macropterous).—Length distended over 1.5 mm. Color dark brown except antennal segment III which is yellow to yellowish brown, apex of each fore tibia and all tarsi which are yellowish brown, and sub-basal region of fore wings and all of hind wings (except longitudinal median streak) which are off-white.

Antennal segments III and IV each with a circumpolar sensory ring composed of two interlocking rows of staggered circular sensoria. Reticulations on prothorax weak, spaced fairly far apart. Posterior lateral margins of abdominal tergites II–VII with setae fused at base into comb plates; median area on abdominal tergites II–V bare except for a middle patch of setae, these setae separate and not fused; abdominal sternites II–VII with accessory setae in addition to the posterior setae; microsetae numerous on most of the dorsal, lateral, and entire ventral surfaces of the abdomen.

MALE (macropterous).—Length distended over 1 mm. Similar to female in color and general structure except posterior comb on abdominal tergite VI incomplete, abdominal sternites II–VIII often without accessory setae in addition to the posterior setae, and fusion of lateral abdominal tergal setae into combs less pronounced. Abdominal sternites III–VIII each with a narrow elliptical anteromedian glandular area. Abdominal tergite IX without finger-like projections.

Like its congener *aesculi*, *azaleae* is a thrips of the southeastern U.S.A. biota whose range barely extends into Illinois. Even though at the limits of its range, the azalea thrips is extremely

abundant in the few suitable Illinois habitats. Neither the thrips nor its host plant are just “hanging on” as fringe populations, but rather both plant and thrips flourish in isolated pockets in the Pine Hills in Union County. Other similar isolated thrips populations have been found to the west across the Mississippi River, in Missouri where azaleas also grow.

Illinois records.—UNION COUNTY: Wolf Lake (Pine Hills), from April 28 to May 10, 1947–1963, on *Azalea roseum*, many ♀, ♂.

Heterothrips limbatus Hood

Heterothrips limbatus Hood (1925a: 124). ♀, ♂. Type-locality.—Macedon, New York.

FEMALE (macropterous).—Length distended over 1.5 mm. Color dark brown except antennal segment III which is yellow, apex of each fore tibia and all tarsi which are yellow, and sub-basal region of fore wings and, except for the median longitudinal streak, all of the hind wings which are off-white.

Antennal segments III and IV each with a circumpolar ring composed of small circular sensoria so staggered as to form either one and one-half rows or sometimes two rows. Reticulations on prothorax distinct, placed fairly far apart, forming hexagonal designs. Entire posterior margins of abdominal segments I–VII, dorsally and ventrally, with setae fused to other setae at base except for the median setae on dorsum of segments VI and VII which are often separate from other setae.

MALE (macropterous).—Length given by Hood (1925a) as about 1 mm. General color and structure reported by Hood to be same as in female. Abdominal tergite IX without finger-like projections. Anteromedian glandular areas present on abdominal sternites IV–VIII only (Hood 1925a).

Although *limbatus* is known so far from only the New England states and vicinity, it is highly probable that the species may occur in Illinois, perhaps on the flowers of *Prunus* or dogwood. Despite repeated searches it has not been found in our state as yet.

Heterothrips quercicola

Crawford, J.C.

Oak Catkin Thrips

Heterothrips quercicola Crawford, J. C. (1942:140). ♀, ♂. Type-locality.—Babylon, Long Island, New York.

FEMALE (macropterous).—Length distended about 1.5 mm. Color dark brown except antennal segment III which is yellow to yellowish brown, apex of each fore tibia and all tarsi which are yellow, and subbasal region of each fore wing and, except for median longitudinal streak, all of hind wings which are off-white.

Antennal segments III and IV each with a circumpolar ring roughly composed of two rows of staggered circular sensoria. Reticulations of prothorax placed fairly far apart scarcely forming polygonal designs. Posterior lateral margins of abdominal tergites II–VII with setae often fused at base to form small comb plates; median areas on abdominal tergites I–V bare except for a middle patch of a few setae, these setae separate and not fused. Abdominal tergite X as in Fig. 91.

MALE (macropterous).—Length distended about 1 mm. Similar to female in color and structure except setae on posterior lateral margins of intermediate abdominal tergites less extensively fused, and posterior comb on abdominal tergite VI interrupted in the middle. Abdominal sternites IV–VIII each with an anteromedian glandular area. Abdominal tergite IX without finger-like projections.

This eastern North American species has been found twice in Illinois. Its host may be *Quercus marilandica*, the black jack oak, a common tree in certain regions of Illinois. Apparently this thrips feeds only on the oak catkins and not the leaves, and because of the short duration of the catkins it is easy to miss the thrips.

Bailey & Cott (1955) suspect that *quercicola* is a synonym of *vernus* Hood. The descriptions of the two "species" are, indeed, remarkably similar if individual variation is taken into account.

Dr. D. L. Wray found adults over-

wintering in the leaf mold of a forested area in North Carolina in late January.

Illinois records.—HARDIN COUNTY: Lamb, April 10, 1963, Stannard, 2 ♀. POPE COUNTY: Hayes Creek Canyon (Eddyville), May 10, 1961, Stannard, in woods, 1 ♀.

***Heterothrips salicis* Shull**

Willow Catkin Thrips

Heterothrips salicis Shull (1909:220). ♀, ♂. Type-locality.—Huron County, Michigan.

FEMALE (macropterous) (Fig. 93).—Length distended about 1.5 mm. Color dark brown except antennal segment III and middle of IV which are mostly yellow, apex of each fore tibia and all tarsi which are yellowish brown, and subbasal region of fore wings and all of hind wings (except longitudinal median brown streak) which are off-white.

Antennal segments III and IV each with a narrow circumpolar ring of sensoria roughly limited to a single row dorsally. Reticulations on prothorax fairly widely spaced. Posterior lateral margins of abdominal tergites I–VII with setae fused at base into comb plates; median area on abdominal tergites I–V bare except for a middle patch of setae on tergites II–V, these middle setae often fused at extreme base; abdominal sternites III–VII with accessory setae in addition to the posterior setae; microsetae on abdominal segments I–VII sparse dorsally and ventrally.

MALE (macropterous).—Length distended over 1 mm. Colored as in female. General structure as in female except abdominal tergite VI with posterior setal combs interrupted in the median region and with some more microsetae on the abdominal segments but fewer to no accessory setae on abdominal sternites III–VIII. Fairly large oval glandular areas present on the abdominal sternites, one each on the mid anterior region of sternites III–VIII. Abdominal tergite IX without finger-like projections.

According to Bailey & Cott (1955), *Heterothrips salicis* is a widespread species occurring from the Midwest to

California. In Illinois it is common on the male catkins of *Salix interior*. The original type material was collected by Shull in Michigan on the same willow although at the time *interior* was known by the now subordinated name *Salix fluviatilis*.

Illinois records.—Collected during

May, June, and July, from one to several localities in the following counties: ALEXANDER, CARROLL, CHAMPAIGN, CLARK, COLES, DE WITT, FORD, FRANKLIN, GRUNDY, HENDERSON, IROQUOIS, JASPER, KANKAKEE, LAKE, LOGAN, LEE, MCHENRY, WABASH, WHITESIDE and WILLIAMSON.

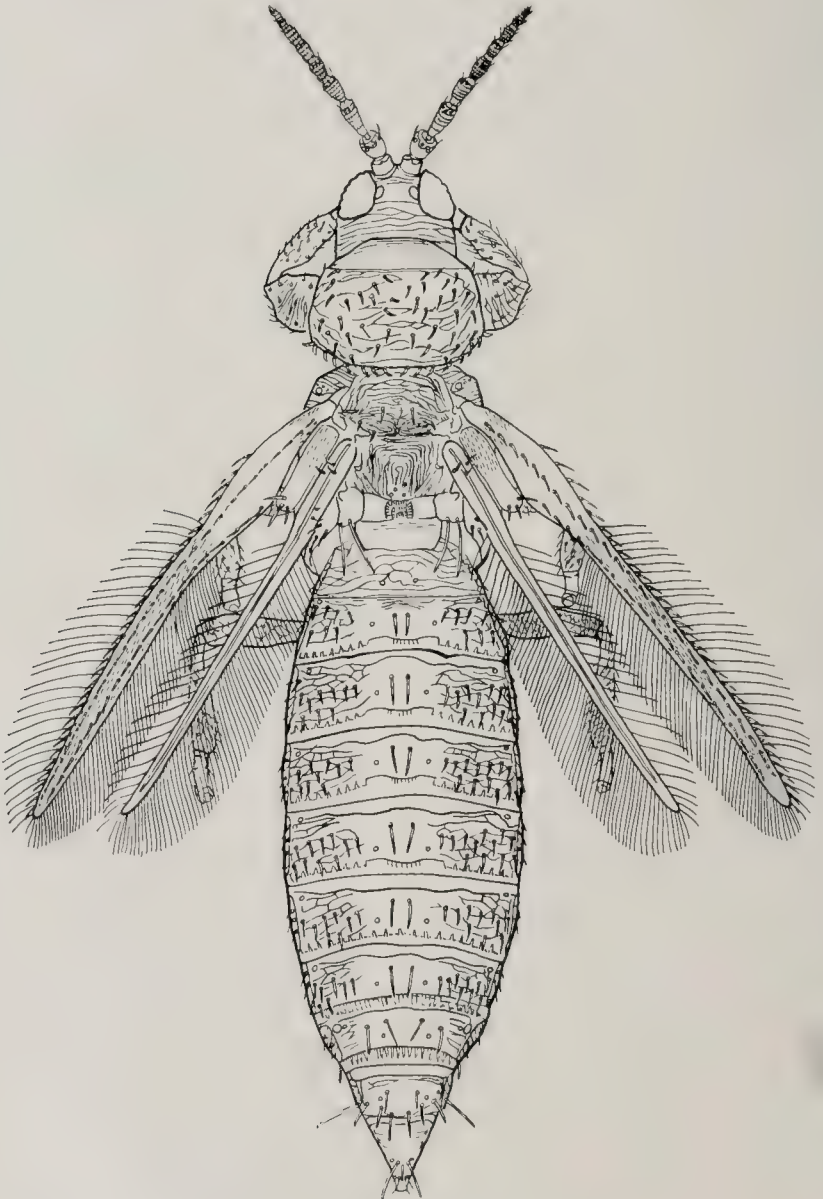


Fig. 93.—*Heterothrips salicis*, dorsal aspect.

Heterothrips vitis Hood
Grape-bud Thrips

Heterothrips vitis Hood (1916c:106).
♀, ♂. Type-locality.—Plummer's
Island, Maryland.
Heterothrips tiliae Watson (1920:29).
♀, ♂. Type-locality.—Gainesville,
Florida. Synonymized by Bailey &
Cott (1955).

FEMALE (macropterous).—Length
distended about 1.2 mm. Color dark
brown except antennal segments III,
IV, and sometimes V which are yellow
to yellowish brown in the basal
three-fourths, apex of each tibia and
all tarsi which are yellow, and subbasal
region of fore wings and, except for
longitudinal median streak, all of hind
wings which are off-white.

Antennal segments III and IV each
with a circumpolar sensory ring composed
of a single staggered row of
small sensoria. Reticulations on pro-
thorax distinct, placed close together,
about as close as the striae on the meso-
scutum. Posterior lateral margins of
abdominal tergites I–VIII with setae
separate, not fused to other setae at
base; median areas on abdominal ter-
gites I–V and sometimes VI bare ex-
cept for a middle patch of setae, these
setae also separate, not fused; ab-
dominal sternites usually without ac-
cessory setae in addition to the poste-
rior setae; microsetae numerous and
generally disposed over the abdomen
except for the bare median region of
tergites I–VII.

MALE (macropterous).—Length
distended less than 1 mm. Similar in
color to female except antennal seg-
ments III–V darker, more nearly
brown. Similar in structure to female
except dorsal posterior setal comb
usually interrupted medially on ab-
dominal segments VI and VIII. Ab-
dominal sternites without glandular
areas. Abdominal tergite IX with two
finger-like projections.

This species is somewhat smaller
than most of its relatives in Illinois.
It was discovered in our state by Dr.
Milton W. Sanderson in Clark County
on June 14, 1950. Since then it has
been found in scattered places over the

state. Primarily it is a thrips of eastern
North America.

Illinois records.—Collected during
May and June on wild grape buds,
from one to several localities in the
following counties: ALEXANDER, CAR-
ROLL, CLARK, GALLATIN, HARDIN, JO
DAVISS, LAWRENCE, LOGAN, and
WASHINGTON.

MEROTHRIPIDAE Hood (1914d)

As represented by the extant species
in North America, this family may be
characterized by the combination of
the eight-segmented antennae, by the
large tympanum-like sensoria which
partially or nearly circle the apex of
antennal segments III and IV, and
often by the reduction of microsetae
on the wings of the macropterous
forms. Members of this family also
lack cocoon-breaking claws on the fore
tarsi.

Only the genus *Merothrips* occurs in
Illinois. The other known genera,
Praemerothrips (based on an amber
fossil), *Erotidothrips*, and *Damero-*
thrips have the antennae each nine
segmented.

The family Merothripidae probably
originated phylogenetically earlier
than the Thripidae (Fig. 26). *Mero-*
thrips, while specialized by degeneracy
in many respects, still retains the prim-
itive tympanum-like sensoria in the
antennae, and the hind vein of the fore
wing still retains its basal spur, basad
of the crossvein. Furthermore, the
other genera in the family have primi-
tive nine-segmented antennae. Mem-
bers of the Thripidae all have the an-
tennae reduced to basically eight seg-
ments. The sensoria of the antennae
are specialized into cones or projecting
forks, and the basal spur of the hind
vein of the fore wing is usually atro-
phied.

Merothrips Hood

Merothrips Hood (1912c:132). Type-
species by original designation.
Merothrips morgani Hood.

Body elongate, slender (Fig. 94),
weakly sclerotized.

Head longer than wide to wider than long. Ocelli present in macropterous forms, absent in apterous forms. Interocellar bristles long. Eyes normal in macropterous forms, reduced (sometimes to four facets per eye) in the apterous forms. Antennae eight segmented, segments III and IV at each apex with a partially to nearly completely encircling tympanum-like sensorium (Fig. 64). Mouth cone broadly rounded. Maxillary palps two or three segmented, labial palps two segmented.

Pronotum usually elongate with lateral margins occurring well on the dorsal side, somewhat as in the manner of *Chirothrips*. Bristles well developed only on the posterior angles of the prothorax. Mesospinasternum fused to metasternum. Fore and hind femora enlarged. Apex of fore tibiae with a small to moderate-sized tooth, largest in males. Fore femora with an inner median spur in some males. Fore wings, when present, without microsetae, with two longitudinal veins, with hind vein continued basad to single crossvein. Both of these veins nearly uniformly set with bristles. Fringe setae straight to slightly wavy.

Abdomen with transverse striations. Pleural plates seemingly not well differentiated. Abdominal sternites usually with a transverse row of median setae (accessory setae) in addition to the posterior ones. Abdominal sternites without posterior combs of setae. Ovipositor in female weak and small. Males without abdominal sternal glands and without thornlike setae on abdominal tergite IX.

Members of this genus, while often found under bark and in insect burrows, occur more abundantly on polyporoid fungi or, as is the case of a Venezuelan species I have studied, on flowers—specifically the old male flowers of an oil palm.

The resemblance of the thorax of *Merothrips* to the thorax typical of *Chirothrips* may be considered to be a parallel evolutionary development, particularly in view of the fact that *Chirothrips*, a member of the higher Thripidae, has few other features sug-

gestive of close relationship to the primitive *Merothrips*.

The species of *Merothrips* often have heterogonously developed individuals, and, accordingly, they are difficult to differentiate when only one form is known. Two excellent keys to the species of the world are now available, one by Dr. Zur Strassen (1959b) and one by Professor Bailey (1960). Only the species *morgani* is found in Illinois.

Merothrips morgani Hood

Merothrips morgani Hood (1912c:132).
♀, ♂. Type-locality.—Homer, Illinois.

FEMALE (apterous) (Fig. 94).—Length distended nearly 1 mm. General color pale brownish yellow with base of head, antennal segment II, and legs yellow. Antennal segments III–VIII brown.

Head (Fig. 95a) longer than wide. Ocelli absent. Eyes each reduced to four facets. Antennae elongate, segments III and IV with apical sensoria barely extended onto ventral surfaces. Maxillary palps three segmented.

Pronotum (Fig. 95b) with a pair of depressed pits medially. Only one pair of posterior bristles well developed. All thoracic striations transverse. Fore tibiae each with a small apical inner tooth.

Abdominal sternites with accessory setae small and few in number.

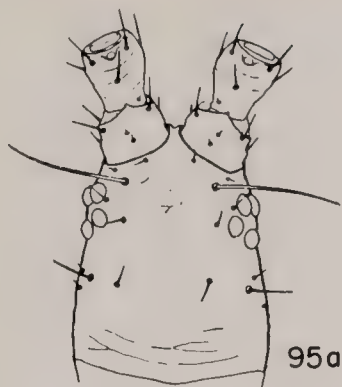
FEMALE (macropterous).—Length distended nearly 1.2 mm. Similar to apterous female except eyes larger, ocelli present, wings fully developed, and metascutum longitudinally striate.

MALE (apterous).—Length distended about 0.9 mm. Similar to apterous female in color and general structure except surface of head largely granulated, pronotum with distinct striations, and fore tibiae often with a larger apical tooth. Males of this species lack an inner spur on the fore femur.

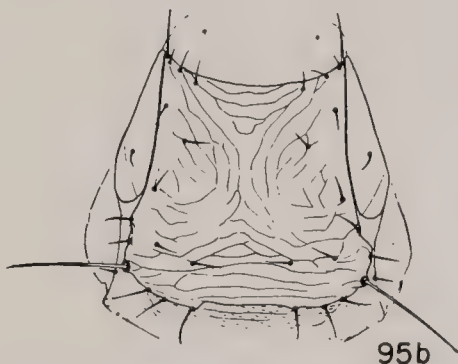
This, the type-species, is one of our smallest thrips. It can be found throughout the state under bark, especially in the fall and winter during the hibernation period, or in the sum-

mer on polyporoid fungi, such as *Polyporus gilvus*, which may be one of its larval hosts (Graves 1960).

Illinois records.—Collected every month of the year, from one to several localities in the following counties: ADAMS, BUREAU, CARROLL, CHAMPAIGN, CLARK, COOK, EFFINGHAM, HARDIN, HENDERSON, JACKSON, KANKAKEE, LAKE, PIATT, RICHLAND (Hood 1912c), VERMILION, and WOODFORD.



95a



95b

Fig. 95.—*Merothrips morgani*: a, head; b, prothorax. From zur Strassen (1959b).

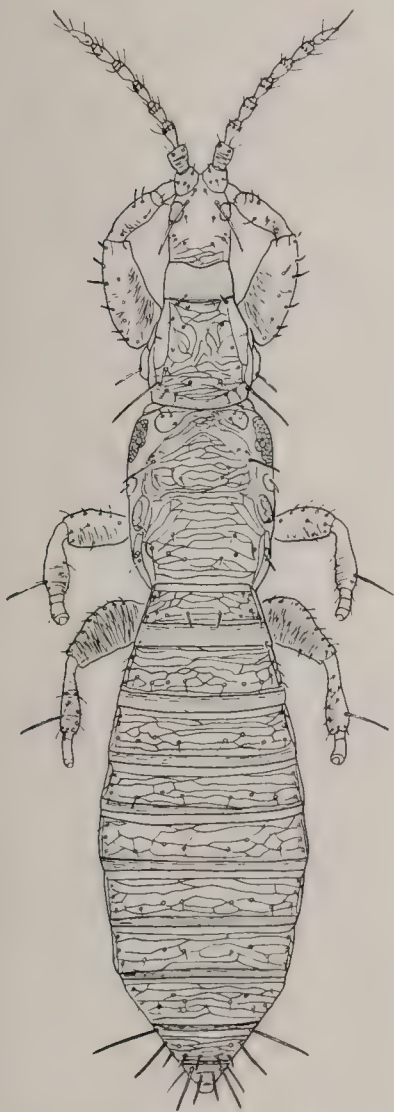


Fig. 94.—*Merothrips morgani*, apterous form, dorsal aspect.

THRIPIDAE Stephens (1829)

In an evolutionary scale these thrips are the most advanced members of the Terebrantia (Fig. 26). They may be distinguished in eastern North America by the combination of the following characteristics: 1) possession of projecting simple or forked sense cones on antennal segments III and IV, 2) downturned ovipositor in the female, and 3) the possession of microsetae on the wing surfaces of winged forms.

Most of the genera of the Terebrantia belong here. The family as represented in Illinois can be divided into two subfamilies, and, in the nominate subfamily into several tribes. For easy reference, however, the genera are listed herein in alphabetical sequence regardless of subfamily or tribal assignment.

Subfamily THRIPINAE Karny
(1921)

Body usually with transverse striations, occasionally with hexagonal reticulations. Head and prothorax without flanged margins. Ocelli usually not on raised areas. Antennae with segment II usually not enlarged, usually with intermediate segments not constricted and elongated appreciably at apexes, and with terminal segments often stylelike but rarely extremely slender. Maxillary palps two or three segmented. Mesospinasternum often separated from the metasternum by a wide suture. Fore wings each with fore vein separated from costa for its entire length. Abdominal tergites sometimes with microsetae. Abdominal sternites sometimes with accessory setae.

This subfamily retains the generalized condition of having the fore vein of the fore wing entirely free from and not fused with the costa. The bulk of the members of the Thripidae belong here.

Although several attempts have been made by authors to divide this subfamily into tribes, no completely satisfactory arrangements have been devised. Tentatively I recognize the following three tribes with the realization that the tribe Thripini, as herein defined, is composed of several diverse groups that should in the future receive further study and be reevaluated.

Tribe DENDROTHRIPINI Priesner
(1926b)

Head often sunken between eyes. Antennal segment II frequently enlarged. Maxillary palps usually two segmented. Mesospinasternum usually fused to metasternum. Metafurcae greatly enlarged. Fore wings with fringe cilia straight. Tarsi usually one segmented. Abdominal tergites either reticulate, transversely striate, or with microsetae-like lines at sides; middle pair of setae closely spaced.

Members of this tribe resemble those in the Sericothripini in general habitus. The great enlargement of the metafurcae is the principal feature of the Dendrothripini and this characteristic usually serves to distinguish

this group from the Sericothripini and others in the subfamily Thripinae. It is interesting to note that representatives in the genus *Selenothrips* of the subfamily Heliothripinae have enlarged metafurcae, which strengthens the hypothesis that the Dendrothripini might have arisen from an ancestor common to both.

Only one genus, *Leucothrips*, represents the tribe Dendrothripini natively in Illinois. Two other genera, *Dendrothrips* and *Pseudodendrothrips*, have been introduced into our state from Europe and Japan. Most of the other related genera occur in the tropics.

Tribe SERICOTHRIPINI Priesner
(1926b)

Head usually relatively short, seldom prolonged in front of eyes and usually not sunken. Antennal segment II not especially enlarged. Maxillary palps usually three segmented. Prothorax usually with characteristic sculpture and bare spots (Fig. 128). Mesospinasternum frequently separated from metasternum by a suture. Fore wings with fringe cilia wavy in species in Illinois, occasionally straight in exotic species, for example in *Psilothrips*. Tarsi two segmented. Abdomen usually with numerous microsetae, middle pair of tergal setae closely spaced.

In Illinois this tribe includes *Drepanothrips*, *Pseudothrips*, *Scirtothrips*, *Sericothrips*, *Zonothrips* and possibly *Echinothrips*. *Echinothrips* has been included in the Heliothripinae by most authors but I prefer to tentatively include this genus in the Sericothripini because the fore vein of the fore wing of *Echinothrips* does not seem to be actually fused to the costa. Furthermore, species of *Echinothrips* often bear numerous microsetae whereas those in the Heliothripinae almost never have more than a relatively few microsetae on the abdomen. The possession of many abdominal microsetae and the type of sculpture on the prothorax are the two chief features characterizing the Sericothripini. (In *Pseudothrips* the microsetae are greatly reduced in size.) Some members of the Sericothripini also have fairly large

metafurcae somewhat approaching those in the closely related tribe, *Dendrothripini*.

Tribe THRIPINI Priesner (1949)

Head various, sometimes prolonged in front of eyes. Antennal segment II occasionally enlarged. Maxillary palps two or three segmented. Metaspinasternum usually separated from metasternum by a suture. Metafurcae rarely enlarged. Fore wings with fringe cilia usually wavy. Tarsi usually two segmented except in some apterous forms. Abdomen without microsetae except occasionally at extreme sides, middle pair of setae usually far apart.

Most of the species in Illinois belonging to the Thripidae have been included in this tribe. I have not separated out *Chirothrips* and *Limoethrips* as members of the tribe Chirothripini, as is often done, because there seems to be no easy way to categorize them.

The bulk of the species in the Thripini can be regarded as general types with few unique characteristics. In depicting their supposed evolutionary descent, the Thripini as a whole could be considered to be more advanced than those in the Heliothripinae, Dendrothripini, and Sericothripini. The main advancement of the Thripini is by degenerate specialization without many unusual elaborations.

Subfamily HELIOTHRIPINAE

Karny (1921)

Body often hexagonally reticulate. Head and prothorax sometimes with margins produced into flanges. Ocelli usually on raised area. Antennal segment II often enlarged, intermediate segments frequently vasiform, terminal antennal segments usually hastate. Maxillary palps usually two segmented. Mesospinasternum usually fused with metasternum. Metafurcae often greatly enlarged. Fore wings each with fore vein fused with costa beyond basal third. Abdominal tergites usually without microsetae. Abdominal sternites usually without accessory setae.

This subfamily is easily distinguished by the characteristic of the

partial fusion of the fore vein of the fore wing with the costa.

Most of the bizarre thrips belong here. The exotic *Aoratothrips* with its periscope-like ocelli, *Arachisothrips* with its balloon-shaped wings, and many of those genera with highly developed tubes are members.

In general the species in this group are tropical in distribution. Only one genus, *Caliothrips*, occurs natively in Illinois. Three other genera, *Heliothrips*, *Parthenothrips*, and *Hercinothrips*, which are tropical in origin, sometimes occur in our state in warm greenhouses and in heated homes.

KEY TO GENERA

(EASTERN NORTH AMERICA)

(The New York genus *Sericopsothrips* Hood (1936c) is known by a single specimen which is difficult to see and categorize. It keys to *Scirtothrips* herein.)

1. Fore vein, as indicated by setae, of fore wing fused to costa in apical two-thirds; antennal segments III and IV usually strongly vasiform and/or terminal segment of style extremely long **HELIOTHRIPINAE 2**
Fore vein of fore wing not fused to costa, or wings reduced to pads or wingless; intermediate antennal segments not usually strongly vasiform; terminal segment of style usually shorter **THRIPINAE 5**
2. Fore wing with fringe cilia straight; median dorsal abdominal setae closely set **Heliothrips**
Fore wing with fringe cilia predominantly wavy; median dorsal setae placed fairly far apart **3**
3. Antennae each seven segmented; fore wings broad **Parthenothrips**
Antennae each eight segmented; fore wings more narrowed **4**
4. Tarsi each one segmented **Caliothrips**
Tarsi each two segmented **Hercinothrips**
5. Metafurcae greatly enlarged; tarsi each one segmented; fore wing fringe cilia always straight **DENDROTHRIPINI 6**
Metafurcae not as enlarged; tarsi each one or two segmented; fore wing fringe cilia straight or wavy **8**
6. General color brown; prothorax lacking well-developed posterolateral setae **Dendrothrips**
General color nearly white; prothorax bearing one or two pairs of well-developed posterolateral setae **7**
7. Antennae seven segmented; prothorax with two pairs of posterolateral setae **Leucothrips**
Antennae eight segmented; prothorax with one pair of posterolateral setae **Pseudodendrothrips**
8. Abdomen with numerous microsetae; median dorsal abdominal setae closely set;

- antennae never nine segmented.
 (in part) **SERICOTHRIPINI** 9
 Abdomen without numerous microsetae, or microsetae extremely short and difficult to see; median dorsal abdominal setae closely set or far apart.
 **THRIPINI**
 (except for *Pseudothrips*, which have antennae nine segmented) 13
9. Antennae each six or seven segmented. 10
 Antennae each eight segmented. 11
10. Antennae each six segmented; fore wings uniformly light grayish brown.
 **Drepanothrips**
 Antennae each seven segmented; fore wings with two brown crossbands.
 **Zonothrips**
11. Sense cones on antennal segments III and IV simple. **Echinothrips**
 Sense cones on antennal segments III and IV forked. 12
12. Fore vein of fore wings uniformly set with setae. **Sericothrips**
 Fore vein of fore wings with setae interrupted; (c.f. *Sericopsithrips*)
 **Scirtothrips**
13. Fore tibiae each with a clawlike process at apex (Fig. 78) **Odonthrips**
 Fore tibiae not usually prolonged at apex or if slightly prolonged never with clawlike processes (Fig. 79) 14
14. Antennal segment II or III greatly or slightly produced at outer apex; prothorax trapezoidal or females with thornlike setae on abdominal tergite X. 15
 Antennal segments II and III never produced at outer apex; prothorax rarely trapezoidal and female never with thornlike setae on abdominal tergite X. 16
15. Prothorax strongly trapezoidal (Fig. 106); legs often stout and stocky (Fig. 79); head small; antennal segment II produced at outer apex; female without thornlike setae on abdominal tergite X.
 **Chirothrips**
 Prothorax not trapezoidal; legs never as stout and stocky; head normal in size; antennal segment II or III produced strongly or slightly at outer apex; female with thornlike setae on abdominal tergite X (Fig. 39) **Limothrips**
16. Prothorax with all major setae exceptionally long, including a long midlateral pair (Fig. 127) **Scolothrips**
 Prothorax either with shorter setae, or, if many major setae long, midlateral pair always short. 17
17. Antennae each six or seven segmented. 18
 Antennae each eight or nine segmented (Fig. 69, 71, and 72) 22
18. Antennae each six segmented (Fig. 74)
 (in part) **Aptinothrips**
 Antennae each seven segmented (Fig. 70) 19
19. Prothorax with postlateral setae generally small; abdominal tergites with strong scallop-like projections along posterior margin **Microcephalothrips**
 Prothorax with two pairs of well-developed postlateral setae; abdominal tergites usually without strong scallop-like projections along posterior margin 20
20. Head prolonged in front of eyes (Fig. 121-123); ovipositor somewhat weakly developed. **Plesiothrips**
 Head not particularly prolonged in front of eyes; ovipositor well developed. 21
21. Maxillary palps each two segmented. **Baliothrips**
 Maxillary palps each three segmented.
 **Thrips**
22. Abdominal tergite VIII with stippled area around spiracles extended up to anterior margin (Fig. 96) (sometimes difficult to see in balsam mounts) 23
 Abdominal tergite VIII without such large stippled areas. 24
23. Body not reticulate; macropterous.
 **Chaetanaphothrips**
 Body reticulate; wingless; not yet found in Illinois. **Prosopothrips**
24. Abdomen with heavy hexagonal reticulations (Fig. 107) **Ctenothrips**
 Abdomen not strongly sculptured with hexagonal reticulations. 25
25. Antennae each nine segmented, or partially nine segmented (i.e., segment VI having a partial suture) 26
 Antennae each eight segmented. 28
26. Median dorsal abdominal setae closely set. **Pseudothrips**
 Median dorsal abdominal setae placed fairly far apart. 27
27. Pronotum with one pair of well-developed epimeral setae (Fig. 119); abdominal tergite VIII without posterior comb of setae. (in part) **Oxythrips**
 Pronotum without well-developed setae; abdominal tergite VIII with complete posterior comb of setae.
 (in part) **Anaphothrips**
28. Antennal segment IV with simple sense cone. 29
 Antennal segment IV with forked sense cone. 31
29. Prothorax without any long setae; always apterous. (in part) **Aptinothrips**
 Prothorax with epimeral setae, at least, well developed; macropterous or brachypterous. 30
30. Abdominal segment X shorter than segment IX in female; male without glandular areas on abdominal sternites;

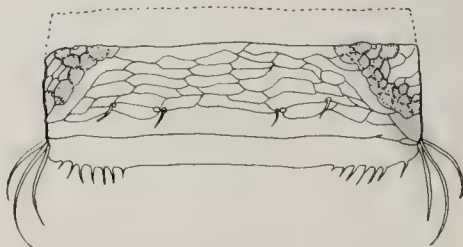


Fig. 96.—*Chaetanaphothrips orchidii*, abdominal tergite VIII, showing differentiated area anterior of each spiracle.

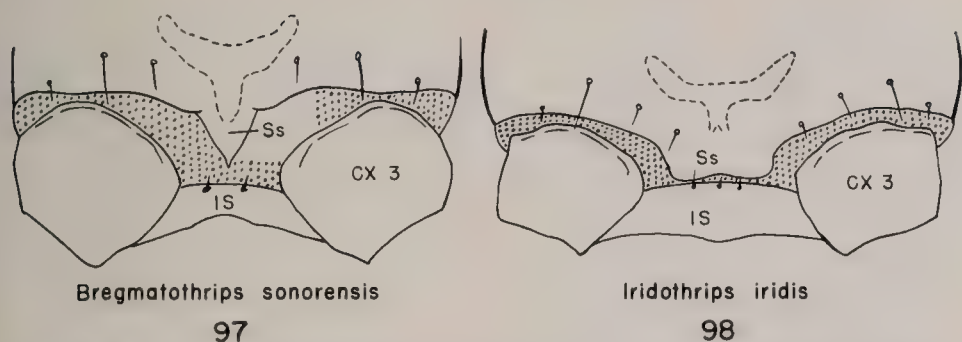


Fig. 97-98.—Differences in form of metaspinasternum between: 97, *Bregmatothrips* as typified by *sonorensis* from Arizona and California; 98, *Iridothrips iridis*. Ss—metaspinasternum, Cx3—hind coxa, IS—abdominal sternite I.

metaspinasternum as in Fig. 97.

Bregmatothrips
Abdominal segment X longer than segment IX in female; male with glandular areas on abdominal sternites; metaspinasternum as in Fig. 98.

Iridothrips
31. Prothorax without any long setae.

(in part) **Anaphothrips**
Prothorax with well-developed setae, either the epimeral setae long or both the epimeral and anteromarginal setae long. 32

32. Prothorax with the anteromarginal and epimeral setae long. **Frankliniella**

Prothorax with only the epimeral setae long. 33

33. Prothorax with only one pair of epimeral setae well developed. 34

Prothorax with two pairs of epimeral setae well developed. 35

34. Mouth cone heavy and long (Fig. 105). **Chilothrips**

Mouth cone shorter.

(in part) **Oxythrips**
35. Two-segmented style much longer (nearly twice as long) than antennal segment VI (Fig. 75); not yet found in Illinois.

Rhaphidothrips
Two-segmented style about equal to or shorter than antennal segment VI. 36

36. Abdominal tergite IX lacking pores; male with tergite IX bearing a pair of sigmoidal posterior processes.

Dorcadothrips
Abdominal tergite IX bearing pores; male with tergite IX entire, lacking posterior processes. **Taeniothrips**

Anaphothrips Uzel

Anaphothrips Uzel (1895:142). Type-species by subsequent designation by Hood (1914a).—*Anaphothrips virgo* Uzel (= *Thrips obscura* Müller). Valid designation according to International Commission of Zoological Nomenclature (1950 & 1961).

Type-species by subsequent designation by Moulton (1933a).—*Anaphothrips ferrugineus* Uzel. Invalid because of prior designation; refer to discussion following.

Neophysopus Schmutz (1913:1016). Type-species by monotypy.—*Neophysopus medioflavus* Schmutz (= *flavicinctus* Karny). Made a subgenus of *Anaphothrips* by Priesner (1926b).

Anaphothrips subgenus *Pseudoarticulella* Shumsher (1942:123). Type-species by original designation.—*Thrips obscura* Müller. Elevated to full genus by Morison (1948). Synonymized by Priesner (1949).

Head about as long as wide. Ocelli present in macropterous and brachypterous forms, absent in apterous forms. Antennae eight or nine segmented, segment III with a forked or single sense cone, segment IV (in Illinois at least) always with a forked sense cone. Maxillary palps three segmented.

Prothorax without strong striations and without any long major setae (in Illinois). Mesospinasternum separated from metaspinasternum by wide suture. Metascutum hexagonally reticulate. Fore legs not enlarged. All tarsi two segmented. Fore wings each with two veins, both veins with short weak setae, setae sparse or interrupted on fore vein, fringe cilia wavy. Macropterous, brachypterous, or apterous.

Abdomen with pleural plates. Tergites and sternites without dense microsetae. Abdominal sternites without

accessory setae in addition to posterior ones. Median pair of setae placed moderately far apart on the intermediate abdominal tergites. Abdominal tergite VIII with a complete posterior comb of setae (in Illinois). Females with median posterior setae of abdominal sternite VIII forward of hind margin. Males with median posterior setae of abdominal sternite VIII on hind margin. Males with U-shaped glandular areas on sternites III-VII (in Illinois) and with four thornlike setae on abdominal tergite IX (in Illinois).

Unfortunately the proper type-species of *Anaphothrips* has been subject to dispute among thysanopterists. Until 1950, when the International Commission of Zoological Nomenclature published the decisions reached in Paris in 1948, it was thought by some that Hood's subsequent designation of the type-species was unacceptable. It was unacceptable because Hood designated a subjective synonym, namely *Thrips obscura* Müller. The nominal species *obscura* Müller was not among the originally included species, but *virgo*, which Hood mentioned as one of the synonyms of *obscura*, was in Uzel's first list.

Moulton (1933a), in keeping with the popular interpretations of the rules of his times, redesignated *Anaphothrips ferrugineus* Uzel as the type-species. In a work on Indian Thysanoptera, Shumsher (1942) followed Moulton and not Hood in the selection of the type-species of *Anaphothrips*, and in this same paper Shumsher set up a new subgeneric name, *Pseudo-articulella*, for *obscurus*. Shumsher's proposals were upheld by Morison in 1948, but suppressed by Priesner in 1949.

The action taken by the International Commission of Zoological Nomenclature, (1950) and recently in the new code Article 67 (e) (1961), sets forth the provision that allows *Anaphothrips virgo* Uzel, not *Thrips obscura* Müller or *Anaphothrips ferrugineus* Uzel, to become the type-species of *Anaphothrips*. These rules validate the subsequent selection of a type-species if an originally included species is found to be a junior synonym of that subsequent selection.

In 1942 Shumsher unjustifiably sunk *Neophysopus* Schmutz under *Anaphothrips* s. str. At least, the reasons Shumsher gave for sinking *Neophysopus* were not justifiable. It was Shumsher's contention that because thysanopterists subsequently had placed certain species in *Neophysopus* and that because one of these species, *ferrugineus*, was supposedly the type-species of *Anaphothrips*, then *Neophysopus* automatically became a synonym of *Anaphothrips*. What Shumsher did not take into account was that *medioflavus* was the type-species of *Neophysopus* by monotypy and that the name *Neophysopus* depends solely upon the placement of its type-species, *medioflavus*, and not upon species later transferred to *Neophysopus*. Of course *Neophysopus* may be an outright synonym of *Anaphothrips* s. str. for zoological reasons not yet published or unknown to me, but it is not a synonymous name for nomenclatural reasons. At present *Neophysopus* is considered to be one of the subgenera of *Anaphothrips* (Priesner 1949).

The five Illinois species belong to the above-mentioned subgenera, *Anaphothrips* s. str. and *Neophysopus*. Representatives of other subgenera are exotic. The subgenus *Hemianaphothrips* Priesner is not generally recognized by American thysanopterists. It is a subgroup characterized by the complete division of antennal segment VI into two segments. For this report those species with segment VI either partially divided or completely divided are placed in *Anaphothrips* s. str.

KEY TO SPECIES

1. Antennae each eight segmented.
 -subgenus *Neophysopus* Schmutz 2
 - Antennae each nine segmented, that is, segment VI is secondarily completely or almost completely subdivided.
 -subgenus *Anaphothrips* s. str. 3
2. Apterous; with setae of posterior comb on abdominal tergite VIII often fused with each other at base.**nanus**
 - Wings present; all setae of posterior comb on abdominal tergite VIII separate, not fused at base.**catwaba**
3. Brachypterous.forms of **obscurus**
 - Macropterous.4
4. Last two abdominal segments dark brown.**cameroni**
 - Last two abdominal segments yellow.5

5. Body often with dark blotches; antennal segments III and IV brownish; posterior comb on abdominal tergite VIII usually short; extreme posterior edge of head with a dorsal dark line. Abdominal tergite IX with major posterior setae brown. **obscurus**
 Body uniformly yellow; without dark blotches; antennal segments III and IV yellowish; head entirely yellow. Abdominal tergite IX with major posterior setae yellow. **sandersoni**

Anaphothrips (Anaphothrips)
cameroni (Bagnall)

Euthrips cameroni Bagnall (1919:271).

♀, ♂. Type-locality.—Semans, Saskatchewan, Canada. Transferred to *Anaphothrips* by Watson (1924a).
Anaphothrips ripicola Hood (1940c: 553). ♀, ♂. Type-locality.—St. Lawrence County (near Wanakena), New York. New synonymy.

FEMALE (macropterous).—Length distended over 1.5 mm. Bicolored brown and bright yellow to almost entirely brown. Yellow to yellowish brown: anterior two-thirds of head, antennal segment I, segments III, IV, and sometimes V at extreme base; sides and median spots on thorax; inside of leg segments; and sometimes sides of abdominal segments II–VII. Rest of body brown, darkest brown in terminal antennal segments and in last two abdominal segments. Often abdomen entirely brown. Abdominal tergite VIII with lateral setae, and IX with major posterior setae, brown. Fore wings grayish yellow. Ocellar pigment red.

Head about as long as wide. Antennae nine segmented. Antennal segments III and IV each with forked sense cones. Mouth cone moderately long and pointed.

Posterior angles of prothorax without any long setae. Metanotum less hexagonally reticulate than in *obscurus*.

Abdominal tergite VIII with a complete comb of setae, these setae not fused with others at the base. Abdominal tergite IX with major setae longer than in *obscurus*. Abdominal tergite X completely split longitudinally.

MALE (macropterous).—Length

distended over 1.2 mm. Color and general structure as in female. Abdominal sternites III–VII each with glandular areas varying from circular to oval to crescent shaped. Abdominal tergite IX with the usual four spinelike setae (Fig. 43).

This dark or bicolored species is similar to *obscurus* in overall appearance but in *cameroni* the color is much darker, the major setae on abdominal tergite IX are longer, and the reticulations on the metathorax are less extensive.

So far, *cameroni* has been found only in the northern portions of Illinois. It is a boreal species occurring from Alaska to Saskatchewan, Minnesota, North Dakota, and upper New York State (INHS, University of Minnesota, University of North Dakota, and USNM records).

Illinois records.—KANKAKEE COUNTY: Wichert, July 25, 1947, English, Stannard, on prairie grasses, 1 ♀. LAKE COUNTY: Zion, August 30, 1955, Moore, Stannard, in sand prairie, 4 ♀, 1 ♂. LEE COUNTY: Amboy, May 31, 1933, Ross, Townsend, on grass, 2 ♀, 1 ♂.

Anaphothrips (Neophysopus)
catawba Hood

Anaphothrips catawba Hood (1938c: 348). ♀. Type-locality.—Rocky Point (Pender County), North Carolina.

FEMALE (macropterous).—Length distended about 1.5 mm. Color pale yellow except apical half of antennal segment IV, apical half of V, and all of VI–VIII which are brown, with IV lightest. Ocellar pigment orange-red.

Head about as wide as long. Ocelli present. Antennae eight segmented. Antennal segment VI without a trace of ventral suture. Antennal segments III and IV each with forked sense cones. Mouth cones moderately pointed.

Posterior angles of pronotum without any long setae.

Abdominal tergite VIII with complete posterior comb of setae, these setae long and not fused with others

at the base. Abdominal tergite X completely split longitudinally.

MALE (macropterous).—Length distended nearly 1 mm. Colored as in female. Abdominal sternites III–VII each with a horseshoe-shaped glandular area (Fig. 50). Abdominal tergite VIII with a complete posterior comb of setae. Abdominal tergite IX with the usual four spinelike setae.

The horseshoe-like glandular areas of *catawba* also are found in males of several species of *Anaphothrips*. Morrison (1930b) illustrated this structure in his figure of *Hemianaphothrips* (*Anaphothrips*) *tersus*.

Anaphothrips (N.) *catawba* is a southern species which extends up into central Illinois. It is found in the upland and sand prairies near forested areas on *Andropogon*.

Illinois records.—ADAMS COUNTY: Liberty, October 23, 1956, Stannard, on *Andropogon*, 3 ♀; Siloam Springs State Park, August 8, 1951, Richards, Stannard, on grass, 2 ♀. HARDIN COUNTY: Karbers Ridge (High Knob), August 18, 1950, Stannard, on *Andropogon*, 1 ♀. JACKSON COUNTY: Gorham (Fountain Bluff), August 16, 1950, Stannard, hilltop prairie, 4 ♀. JOHNSON COUNTY: Vienna, August 17, 1950, Stannard, prairie, 1 ♀. MASON COUNTY: Bath, October 2, 1951, Sanderson, Stannard, on *Andropogon*, 1 ♀; Forest City, September 11, 1953, Ross, Stannard, on *Andropogon*, 1 ♀. POPE COUNTY: Herod, August 17, 1951, Ross, Stannard, on *Andropogon*, 7 ♀, 7 ♂.

Anaphothrips (Neophysopus) nanus Hood

Anaphothrips (*Neophysopus*) *nanus* Hood (1941:141). ♀. Type-locality. —Ithaca, New York.

FEMALE (apterous).—Length distended about 1 mm. Color entirely yellow except apical antennal segments. Brown: apex of antennal segment V, apical half of segment VI, and all of VII and VIII. Setae pale.

Head about as long as wide. Ocelli absent. Antennae eight segmented. Antennal segment VI without a trace of a ventral suture. Antennal segment

III with a single sense cone, segment IV with a forked sense cone. Mouth cone short and broadly rounded.

Pronotum with striae faint. Pronotum without any well-developed setae. Pterothorax modified to the usual apterous, degenerative conditions.

Abdominal tergite VIII with complete posterior comb, the setae of which are short and frequently fused with other setae at the base. Abdominal tergite X completely split longitudinally.

MALE.—Unknown.

This species is the only completely apterous member of *Anaphothrips* in Illinois. It can be further distinguished by the unique condition of the posterior comb on abdominal tergite VIII in which many of the setae are fused with others at the base.

Originally described from New York, this tiny species has subsequently been found in Virginia (Dean Floyd Andre, Iowa State University, verbally) and now in Illinois.

Illinois record.—MASON COUNTY: Teheran, October 20, 1953, Smith, Stannard, on *Andropogon*, 1 ♀.

Anaphothrips (Anaphothrips) obscurus (Müller) Grass Thrips

Thrips obscura Müller, O. F. (1776: 96). ♀. Type-locality.—Denmark. Placed in *Anaphothrips* by Reuter, O. M. (1899).

Limothrips poaphagos Comstock (1875:120). *Nomen nudum*. Synonymized by Priesner (1926b).

Thrips striata Osborn (1883:155). ♀. Type-locality.—Ames, Iowa. Synonymized by Hood (1914a).

Anaphothrips virgo Uzel (1895:148). ♀. Type-locality.—Presumably Praha (Prague), Czechoslovakia. Synonymized by Hood (1914a).

FEMALE (macropterous).—Length distended nearly 1.5 mm. Color yellow (yellowish green in life) with some light brown spots. Brown to light brown: narrow band at posterior margin of head, antennal segments II–IX except lighter in the intermediate segments, tip of mouth cone, spots on the thorax, most of abdominal tergite I,

and large median spots covering much of the dorsum of abdominal segments II-VII. Fore wings greyish yellow. Abdominal tergite VIII with lateral setae yellow. Ocellar pigment red.

Head not as long as wide. Ocelli present. Antennae nine segmented (Fig. 72), although suture between segments VI and VII not quite complete. Antennal segments III and IV each with forked sense cones. Mouth cones moderately long and pointed.

Prothorax without any long setae at posterior angles.

Abdominal tergite VIII with a complete posterior comb of setae; these setae often short, none of which is fused with others at base. Abdominal tergite X almost completely split longitudinally.

FEMALE (brachypterous).—Length distended more than 1.5 mm, slightly larger than macropterous form. Similar to macropterous form except often many of the brown spots of the body absent, suture between antennal segments VI and VII often complete, and wings reduced to pads.

MALE.—Unknown to me.

As is usual with an insect that has been long known by entomologists and that ranges over the whole of Europe and North America and causes considerable economic damage, this thrips has had a checkered taxonomic history. Priesner (1926b) has given a full, long list of the different names that have been assigned to *obscurus* in the past. There is still a shadow of doubt that *Anaphothrips virgo* is the same species as Müller's type specimen of *obscurus*. However, it might be nomenclatorially prudent to ignore the *virgo-obscurus* problem and accept the longstanding concept of *obscurus* as employed by such European workers as Bagnall, Priesner, and Pélikan.

Shull (1909) described what he thought was the male of *obscurus* under the synonymous name *striatus*. The two specimens he described were from Huron County, Michigan. I have seen one of these males, deposited in the British Museum (Natural History), and it is the male of *sandersoni*, not *obscurus*. Hood (1938a) made reference to the male of *obscurus*, stating

that "the glandular areas on the abdominal sternum of the male (of *zizania*) are very different in form from those of *obscurus* . . ." I do not know of an article in which the male of *obscurus* is adequately described. Certainly the male of this species, if it exists in North America, is rare. It has not been found in Illinois as yet.

According to Hinds (1900) this species, the grass thrips, hibernates over the winter in the adult female stage. In the spring, when the bluegrass begins to grow again, the females lay their eggs in slits made in the grass leaves. Each female makes these slits by means of her sawlike ovipositor. As soon as the larvae hatch from these eggs they seek protected places in order to feed, usually down in the sheath or in the developing grass head. Often the feeding larvae girdle the grass, which results in the death of the top portion of the grass, a condition known as "silver top" (Fig. 99). Pupation takes place either where the larvae fed or under some of the older sheaths. Apparently there are several generations a year. The overwintering females are composed largely of brachypterous forms. Winged forms are more common in late spring and early summer.

Bluegrass, *Poa pratensis*, is one of the favorite hosts of this thrips. We received our bluegrass from Europe and there is every likelihood that neolithic man brought it to Europe from elsewhere. The original home of the bluegrass remains a mystery. So too does the provenience of *obscurus*, whose tie-up with bluegrass is close.

Anaphothrips obscurus also feeds on other grasses and on corn (*Zea mays*). In Illinois and elsewhere (Anonymous 1963b) this thrips can seriously stunt seedling corn, and even set back older plants. Many farmers occasionally have to use insecticides to combat this thrips. Hewitt (1912) has reported that *obscurus* also damages oats in some areas. Forbes (1892) recalled his early suspicions of 1883 that silver top of timothy in northern Illinois was undoubtedly caused by a species of thrips. Presumably that species was *obscurus*, also.

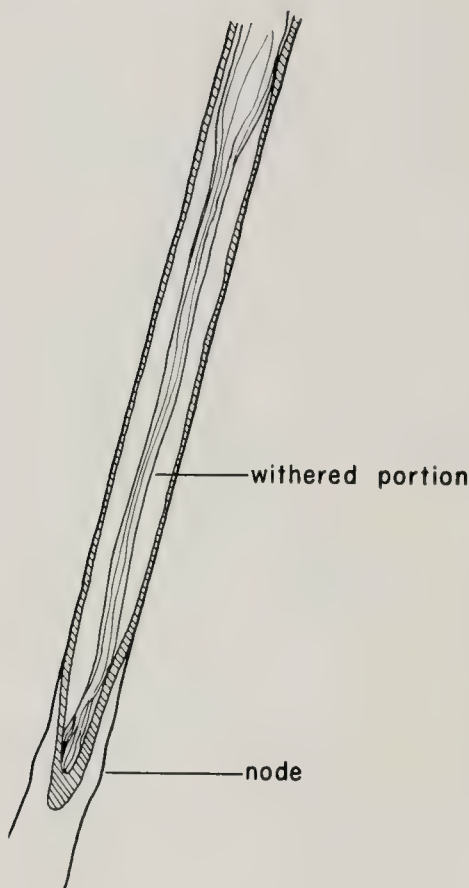


Fig. 99.—Cutaway showing “silver top” damage to blue grass (*Poa pratensis*) by larva of *Anaphothrips obscurus*. Larva, by sucking juices, produces a withered portion just above node that results in death to the terminal growth, which in turn fades into a silver gray color.

Illinois records.—Females and larvae only, collected from April through September, from one to several localities in the following counties: BROWN, BUREAU, CHAMPAIGN, CLAY, COOK, CRAWFORD, EDWARDS, EFFINGHAM, FAYETTE, GALLATIN, GREENE, GRUNDY, HANCOCK, HARDIN, HENDERSON, IROQUOIS, KANE, LAKE, LA SALLE, LIVINGSTON, LOGAN, MARION, MASON, MCHENRY, MORGAN, OGLE, PERRY, PIKE, POPE, PULASKI, ROCK ISLAND, SANGAMON, STEPHENSON, VERMILION, WABASH, WILL, and WINNEBAGO.

Anaphothrips (Anaphothrips) sandersoni Stannard

Anaphothrips (Anaphothrips) sandersoni Stannard (1957a:172). ♀, ♂.
Type-locality.—Kinmundy, Illinois.

FEMALE (macropterous) (frontispiece).—Length distended about 1.5 mm. Color yellow except for apex of antennal segment V, all of antennal segments VI–IX, and tip of mouth cone, which are brown. Fore wings grayish yellow. Ocellar crescents red.

Head about as long as wide. Ocelli present. Antennae nine segmented, antennal segments III and IV each with a forked sense cone. Mouth cone long and pointed.

Posterior angles of pronotum without any long setae.

Abdominal tergite VIII with a complete comb of setae, these setae long and not fused with each other at base. Abdominal tergite X completely split longitudinally.

MALE (macropterous).—Length distended over 1 mm. Similar to female in color and general structure. Abdominal sternites III–VII each with a horseshoe-shaped glandular area, the glandular area on segment VII often smaller and more crescent-shaped than horseshoe-shaped, none of the glandular areas as turned in posteriorly as those found in *catantaba*. Abdominal tergite VIII with a complete posterior comb of setae. Abdominal tergite IX with four stout spinelike setae (Fig. 43).

This distinctive species is named for Dr. Milton W. Sanderson, our Survey's coleopterist, who took me to the prairie areas where these thrips were first found, who collected them later while on vacation in Kansas, and who has discovered many other new records of thrips in the states bordering the Mississippi valley.

Anaphothrips sandersoni may be distinguished from the other yellow-colored species with complete posterior combs on abdominal tergite VIII that occur in the eastern states by the possession of fully developed wings, the nine-segmented condition of each antenna, the long mouth cone, and the

coarser type of head and pronotal striations.

This species is apparently limited to the midwestern prairie regions. It is abundant on *Spartina*, which may have been its original, principal host. Part of Shull's description (1914) of the behavior of *Anaphothrips striatus* on *Spartina* undoubtedly pertains to *sandersoni* instead.

Illinois records.—Collected during spring and summer, from one to several localities in the following counties: BOND, CHAMPAIGN, CLINTON, COOK, DE WITT, DOUGLAS, DU PAGE, FAYETTE, FORD, FULTON, GRUNDY, HANCOCK, IROQUOIS, KANE, LEE, LIVINGSTON, LOGAN, MARION, MARSHALL, MASON, MERCER, PIATT, PIKE, STARK, STEPHENSON, and VERMILION.

Aptinothrips Haliday

Thrips subgenus *Aptinothrips* Haliday (1836:445). Type-species by subsequent designation by Westwood (1839).—*Thrips rufa* Gmelin. Raised to full generic rank by Lindeman (1887).

Uzeliella Bagnall (1908a:5). Type-species by monotypy.—*Uzeliella lubbocki* Bagnall. Synonymized by Priesner (1926b).

Head elongate, slightly prolonged in front of eyes. Ocelli absent. Antennae six or eight segmented, segments III and IV each with simple sense cones. Maxillary palps three segmented.

Prothorax moderately setose without any long marginal setae. Pterothorax partially divided into the mesothorax and metathorax by an incomplete suture. Mesospinasternum separated from metasternum by a suture. Legs stout, tarsi one or two segmented. Always apterous.

Abdomen slender, cylindrical. Abdominal tergites with many scattered small setae, with median pores widely separated and located near posterior margin. Abdominal tergite VIII without comb of setae on posterior margin. Abdominal sternites with accessory setae. Abdominal segment X strongly sclerotized with longitudinal furrows.

Females with long or short posterior median setae on abdominal tergite IX. Males without glandular areas on abdominal sternites, and with two pairs of stout median setae on abdominal tergite IX.

This genus resembles several other apterous genera such as *Prosopothrips* and *Prosopoanaphothrips*, neither of which occurs in Illinois. *Prosopothrips* differs in having fine setae-like combs on the posterior margins of the abdominal tergites, and *Prosopoanaphothrips* is distinctive by its heavy reticulations and cleft prolongation of the head.

Only one species of *Aptinothrips* occurs in our state. This species, *rufus*, has two forms, the nominate form and the "styliifer" form.

Aptinothrips rufus (Gmelin)

Thrips rufa Gmelin (1788:2224). ? ♀.

Type-locality.—? Germany. Transferred to *Aptinothrips* by Haliday (1836). Haliday (1852:1104). ♂.

Aptinothrips styliifera Trybom (1894:41). ? ♀. Type-locality.—? Sweden.

Synonymized by Uzel (1895).

Uzeliella lubbocki Bagnall (1908a:5).

♀. Type-locality.—Whitley Bay, Northumberland, England. Synonymized by Priesner (1926b).

Thrips (Aptinothrips) nitidula Haliday (1836:446). ♀. Type-locality.—England. Synonymized by Speyer (1935).

FEMALE, nominate form (apterous) (Fig. 100).—Length distended nearly 1.5 mm. General color yellow. Antennal segments IV and V, sides of tibiae, and sometimes sides of abdomen, shaded with brown; antennal segment VI and tip of abdomen becoming dark brown.

Head faintly reticulate in anterior two-thirds, transversely striate in posterior third. Antennae each six segmented (Fig. 74); segment II not with flanged sides; segment VI large, composed of morphological segments VI–VIII.

Tarsi each one segmented.

Abdominal tergite IX with median posterior setae short.

FEMALE, "styliner" form (apterous).—Similar to nominate form in color and structure except that antennae each eight segmented (Fig. 73), tarsi each two segmented, and abdominal tergite IX with median posterior setae long and thickened.

MALE (apterous).—Length dis-

tended about 1 mm. Similar to female of corresponding form except lighter. Abdominal sternites without glandular areas. Abdominal tergite IX with two median pairs of short, stout, spinelike setae, the anterior pair being the stoutest.

This species has been the subject of controversy since its description. As indicated by the synonymy, it is a species of considerable variability. Some authors contend that the forms represent true species and are not merely forms of the same species. In 1954 Dr. Bagnall took me to the mouth of the Thames in England, where we collected the brown phase of this species. Dark forms are also known to exist along the northern coast of continental Europe (Prof. Dr. H. Priesner, Linz, Austria, personal communication, 1960).

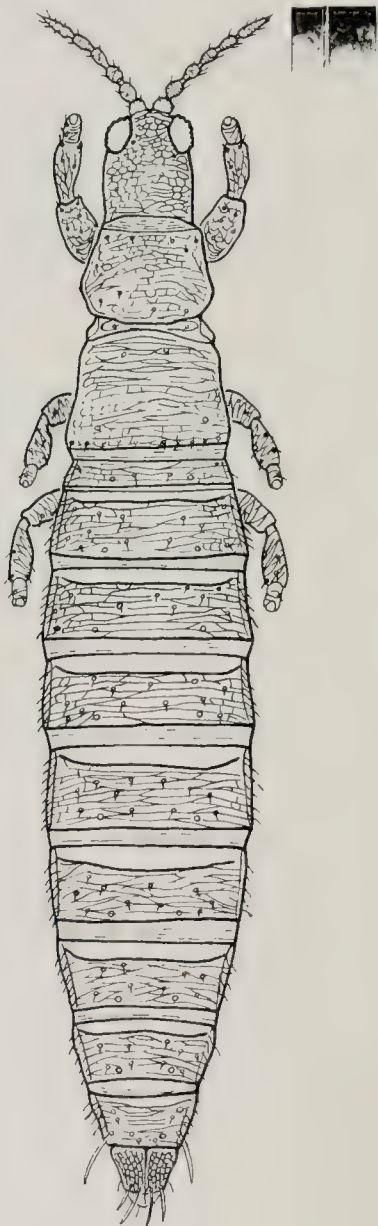


Fig. 100.—*Aptinotrips rufus*, nominate form, dorsal aspect.

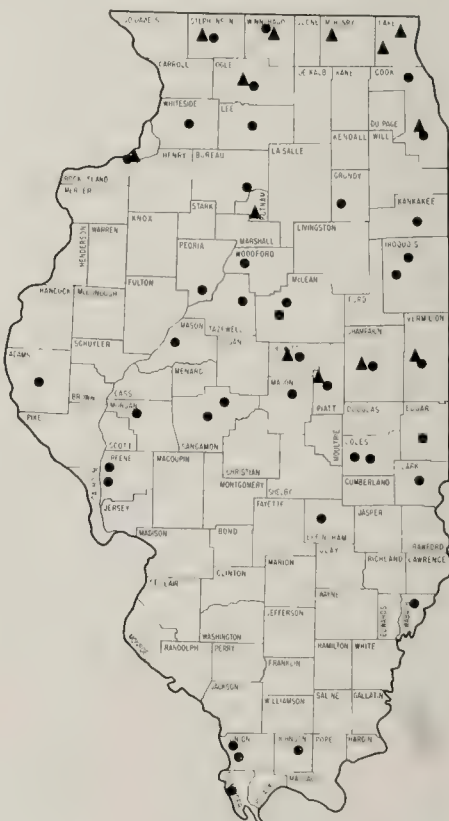


Fig. 101.—Distribution of *Aptinotrips rufus* in Illinois, nominate form in circular dots and "styliner" form in triangular marks.

The "stylifer" form is found only in the northern half of Illinois and the nominate form occurs over the entire state (Fig. 101). Males are extremely rare and have not been found to date in Illinois.

Apparently *rufus* causes damage to grass and grains, but to what extent has not been ascertained for Illinois.

Illinois records. (Fig. 101).—Collected every month of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, BUREAU, CHAMPAIGN, CLARK, COLES, COOK, DE WITT, EDGAR, EFFINGHAM, GREENE, GRUNDY, IROQUOIS, JOHNSON, KANKAKEE, LAKE, LEE, MACON, MASON, MCLEAN, MCHENRY, MORGAN, OGLE, PEORIA, PIATT, PUTNAM, ROCK ISLAND, SANGAMON, STEPHENSON, TAZEWELL, UNION, VERMILION, WABASH, WHITESIDE, WINNEBAGO, and WOODFORD.

Baliothrips Uzel

Baliothrips Uzel (1895:204). Type-species by monotypy.—*Thrips dispar* Haliday.

Head moderate in size, slightly wider than long; area between eyes slightly rounded in front. Ocelli placed close together in a triangle. Interocular and postocular setae small. Antennae seven segmented, segments III and IV each with a forked sense cone. Mouth cone moderately developed, somewhat pointed at the tip. Maxillary palps two segmented.

Prothorax with the epimeral setae well developed, rest of setae much smaller. With three pairs of setae along posterior margin of prothorax between the epimeral pairs of setae. Mesospinasternum separated by a suture from metasternum. Metascutum longitudinally striate. Tarsi two segmented. Fore wings with two veins, hind vein evenly set with setae, fore vein with setae interrupted; fringe cilia wavy.

Abdominal sternites without accessory setae, with posterior pair of setae placed forward of margin in most sternites (in the species in Illinois). Median pair of setae placed far apart on intermediate tergite. Female with

well-developed ovipositor, and with abdominal tergite X partially split. Males with a glandular area on abdominal sternites III–VII, and without thornlike setae on abdominal tergite IX.

In Illinois, this genus most closely resembles the genus *Thrips* except in two features. *Baliothrips* bears a two-segmented maxillary palp and most of the abdominal sternites have the median pair of posterior setae placed forward of the margin. In the species of *Thrips*, the maxillary palps are each three segmented and, except for abdominal sternite VIII, the median pair of posterior setae are placed on the posterior margins of the sternites.

Only one species, *dispar*, is found in our state.

Baliothrips dispar Haliday

Thrips dispar Haliday (1836:449). ♀, ♂. Type-locality.—England. Transferred to *Baliothrips* by Uzel (1895).

Thrips brevicornis Haliday (1836:449). ♀. Type-locality.—England. Synonymized by Haliday (1852).

Baliothrips basilis Shull (1909:224). ♀, ♂. Type-locality.—Huron County, Michigan. Synonymized by Hood (1927c).

Bagnallia agnessae Bagnall (1911b:7). ♀. Type-locality.—Gibside, Durham County, England. Synonymized by Bagnall (1914).

Bagnallia halidayi Bagnall (1911b:8). ♂. Type-locality.—Epping Forest, near Chingford, England. Synonymized by Priesner (1925c).

FEMALE (macropterous).—Length distended about 1.4 mm. General color dark brown. Antennal segments III and IV, apices of tibiae, and all of tarsi yellow to yellow-brown. Fore wings pale at base, pale brown in middle, brown at tip, and brown basad to paler middle area. Ocellar pigment red.

Head moderate in size. Antennae short.

Prothorax almost entirely bare of setae in center.

Abdominal tergite VIII without a complete comb of setae on posterior margin.

MALE (macropterous).—Length

distended about 1 mm. Similar to female in color and structure except somewhat lighter. Abdominal glandular areas narrow and elongately transverse, one each on sternites III–VII.

Although reported to be in North America by Shull under the name *Baliothrips basilis* as early as 1909 and later reported from New York by Hood (1927c), this species has been rarely noted subsequently. Presumably it is a holarctic insect, but it is not nearly as common in our country as it is said to be in England.

We have taken this marsh-and grass-dwelling species once in Illinois. The short-wing forms found elsewhere were not present in this collection. I have studied other specimens from Czechoslovakia and from the Great Smokey Mountains National Park.

Illinois record.—MORGAN COUNTY: Concord, May, 1934, Frison, Ross, on grass around Lake Concord, 3 ♀, 2 ♂.

Bregmatothrips Hood

Bregmatothrips Hood (1912a:66).

Type-species by original designation.—*Bregmatothrips venustus* Hood.

Limocercyothrips Watson (1926b:9).

Type-species by original designation.—*Limocercyothrips bicolor* Watson. Synonymized by Priesner (1949).

Head about as long as wide to longer than wide, considerably bulged in front of eyes. Antennae eight segmented, antennal segments III and IV with simple sense cones. Ocelli present in macropterous forms; present, partially reduced, or absent in brachypterous forms. Mouth cones pointed. Maxillary palps three segmented, rarely reduced by fusion to the two-segmented condition.

Prothorax with setation similar to the Mediterranean genus *Collembolothrips*, that is, with two pairs of long epimeral setae; with one pair each of shorter anterolateral, midlateral and midposterior setae; and with the anterolateral setae set medially away from the anterolateral corner.

Mesospinasternum separated from

the metasternum by a suture. Metaspinasternum pointed (Fig. 97). Fore legs not enlarged. All tarsi two segmented. Fore wings with two veins; setae on fore vein interrupted, setae on hind vein evenly spaced; fringe cilia wavy. Females macropterous or brachypterous; males, as far as is known, always brachypterous.

Abdomen with pleural plates. Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal sternites without accessory setae. Abdominal tergite VIII without a posterior comb. Abdominal segment X shorter than segment IX in female. Males without abdominal sternal glandular areas and without thornlike setae on abdominal segment IX.

Another characteristic of this genus is that of color phases. All macropterous forms are uniformly brown, whereas all brachypterous forms are bicolorous brown and yellow. (See *Iridothrips* for a comparison of the features of the two genera.)

Species of *Bregmatothrips* live in grasslands, particularly in the South. Only one species occurs in Illinois, and it is more common in the southern half than in the northern half of the state.

Bregmatothrips venustus Hood

Bregmatothrips venustus Hood (1912a:67). ♀. Type-locality.—Brownsville, Texas.

FEMALE (macropterous).—Length distended over 1.5 mm. Body dark brown. Appendages brown and yellow. Brown: antennal segments I, II (except apex which is brownish yellow), VI (except base which is brownish yellow), VII and VIII, and femora (except apices which are brownish yellow). Yellow: antennal segments III–V, tibiae, and tarsi. Occasionally outer edge of mid and hind tarsi bordered by brown. Fore wings pale gray.

Head (Fig. 102) about as long as wide to longer than wide. Ocelli present. Prothorax usually with two or three (sometimes four) minor and one major pair of posterior setae between the epimeral setae. Abdominal seg-

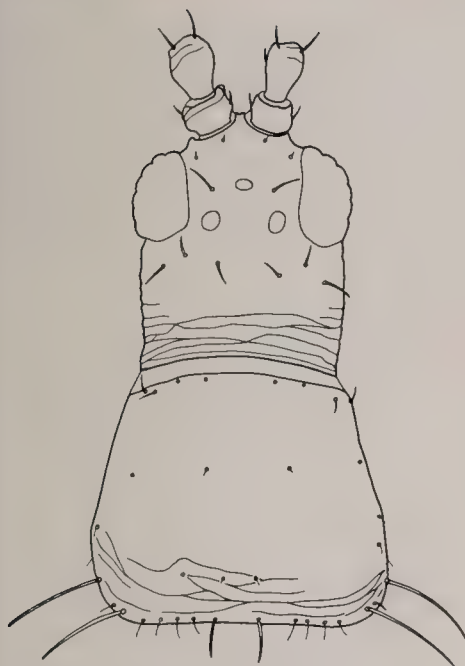


Fig. 102.—*Bregmatothrips venustus*, head and prothorax.

ment X without thornlike setae (Fig. 40).

FEMALE (brachypterous).—Length distended over 1.5 mm. Bicolored brown and yellow. Brown: head; antennal segments I, II (except apex), VI (except base), VII, and VIII; prothorax; and abdominal segments II–X. Rest of body yellow.

Structurally similar to macropterous female except ocelli often absent; according to Hood (1912a) if ocelli present, anterior one degenerate or absent.

MALE (brachypterous).—Length distended over 1 mm. Similar to brachypterous female in color and structure except prothorax yellow. Abdominal sternal glandular areas absent. Abdominal tergite IX without thornlike setae.

This native grassland thrips ranges throughout Illinois. It is a thrips of the midcontinent unless the entity called *gracilis* is merely the Floridian variant of *venustus* and not a distinct species. Moulton (1929a) recorded *venustus* from Cuba. (The specimens upon which this record was based are not

available to me.) Apparently in Mexico *venustus* may become a minor pest of corn. In Illinois it has not yet been listed among the economically important insects.

Another species, *sonorensis*, occurs in the western part of the United States (Stannard 1956b).

Besides the specimens taken in Illinois, we have collections from Lawrence, Kansas; Rogers and Mt. Magazine, Arkansas; and Jalostoc, Morelos, Mexico.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, CALHOUN, CHAMPAIGN, COOK, DOUGLAS, DU PAGE, EFFINGHAM, GALLATIN, GRUNDY, HANCOCK, IROQUOIS, JACKSON, JEFFERSON, JO DAVIESS, KANKAKEE, LAKE, LAWRENCE, LEE, MORGAN, PIKE, PUTNAM, RICHLAND, SALINE, and WILLIAMSON.

Caliothrips Daniel

Caliothrips Daniel (1904:296). Type-species by monotypy.—*Caliothrips woodworthi* Daniel.

Herciothrips Hood (1927d:233). Type-species by original designation.—*Heliothrips striatus* Hood. Synonymized by Priesner (1949).

Head without sharp necklike constrictions as in *Herciothrips*. Antennae eight segmented; segment III more globular than as in *Heliothrips*, *Herciothrips*, or *Echinothrips*; segment VIII 2–2½ times as long as segment VII. Antennal sense cones forked on segments III and IV. Maxillary palps two segmented but with indications of the fusion point between morphological segments II and III.

Prothorax hexagonally reticulate, not transversely striate as in the tropical genus *Selenothrips*, without distinctive long setae on the posterior angles as in *Echinothrips*. Metathorax without a V-shaped hump as in *Heliothrips*. Mesospinasternum almost completely fused to metasternum. Tarsi one segmented. Hind coxae closely spaced. Fore wings pointed at tip, with a row of stout setae and a row of slender setae along the leading edge.

Abdomen, laterally at least, with

fused comblike plates on the posterior margin of the dorsum of each segment. Males with a glandular area on the medial part of sternites III–VII.

Body reticulate, usually black or dark brown in color.

Although the type of *Caliothrips woodworthi* Daniel is not available and presumed lost, the name almost certainly applies to entities formerly placed in *Hercothrips*. As early as 1907, Moulton suppressed *woodworthi* as a synonym of *Heliothrips fasciatus* Pergande, but later the name *Hercothrips* came into general usage. Following Hood's personal confirmation, Priesner in 1949 recognized *Caliothrips* as the prior name and synonymized *Hercothrips* with it. Thysanopterists are now in agreement with Priesner's decision (Faure 1962).

Originally many of the species now in this genus were described in *Heliothrips*. Hood (1927d) created *Hercothrips* for entities thereupon removed from *Heliothrips*. Later (1932) Bagnall further separated off other species, placing them in *Hercinothrips*. All of these thrips as well as some in additional genera greatly resemble each other and form a closely knit, natural phyletic line in the Heliothripinae.

Hood (1927d) surmised that because of the close spacing of the hind coxae, species of *Caliothrips* might be good jumpers as is the case in several other genera similarly formed. Previously Russell (1912) reported that *Caliothrips fasciatus* leaps actively and for considerable distance.

If *Caliothrips fasciatus* (the bean thrips) is typical, thrips of this genus have two larval and two pupal stages. The mature larva drops to the ground and crawls into the soil where both pupal stages occur. No cocoon is spun. Later the adult emerges, provided the crack in which the larva entered the ground has not been closed meanwhile. According to Bailey (1933) the newly emerged adult is unable to dig its way out to the surface, but must come up by way of existing tunnels or fissures.

Three species of this genus are ordinarily found in Illinois. Another species, *fasciatus*, once was found as an

adventive in Urbana on naval oranges transported from California (Russell 1912). Possibly *phaseoli* might also occur on legumes, although it has not yet been found in our state.

Faure (1962) has presented an illustrated key to the species of the world.

KEY TO SPECIES

1. Sides of abdominal tergites more or less transversely striate.....2
Sides of abdominal tergites more or less hexagonally reticulate.....3
2. Fore wings each with two enlarged, dark setae at region of fork of veins; on *Liriodendron*.....*striatus* (Hood)
Fore wings lacking especially enlarged venal setae; on legumes.....*phaseoli* (Hood)
3. Fore wings with three dark crossbands in addition to dark basal spot.....*fasciapennis* (Hinds)
Fore wings with two dark crossbands in addition to dark basal spot.....4
4. Antennal segment III mostly pale with only a light cloud of brown; fore wings with hind vein usually bearing four or five major venal setae; males with small circular glandular areas on sternites of the abdomen.....*cinctipennis* (Hood)
Antennal segment III with apex dark brown; fore wings with hind vein usually bearing six major venal setae; males with wide, oblong glandular areas on sternites of the abdomen.....*fasciatus* (Pergande)

Caliothrips cinctipennis (Hood)

Heliothrips cinctipennis Hood (1912c: 137). ♀, ♂. Type-locality.—Not stated, but holotype labeled Makanda, Illinois. Transferred to *Hercothrips* by Hood (1927d). Transferred to *Caliothrips* by Faure (1962).

FEMALE (macropterous) (Fig. 103).—Length distended almost 1.2 mm. General color blackish brown with brown and white banded wings. Dark brown: most of insect. Yellow to nearly white: legs except middle of femora and tibiae, and antennal segments III–V except for a faint brown cloud in the middle or near apexes of these segments. Fore wings with two dark crossbands in addition to the dark spot at the base. Antennae as in Fig. 66. Sides of abdomen more or less hexagonally



Fig. 103.—*Caliothrips cinctipennis*, dorsal aspect. Photo by W. E. Clark.

reticulate. Posterior margin of abdominal segment VIII on dorsum with a nearly complete setal comb. Without heavy, stout, black spines in the middle of the fore wings.

MALE (macropterous).—Length distended less than 1 mm. Colored as in female. Comb on abdominal segment IX less extensive. Abdominal sternites III–VII each with a small, median, nearly circular, glandular area.

This eastern species is a grassland inhabitant. It is often found in prairie

remnants in parts of the central and all of the southern portions of Illinois. Besides the Illinois material, I have also examined specimens from Kentucky, Arkansas, and eastern Kansas.

This species is similar to the Western *fasciatus*. However, the two can be immediately and easily distinguished by color as well as by other features. In *fasciatus* the third antennal segment has a dark brown band, the band at the tip of the fore wing is more extensive, abdominal tergite VIII has the posterior comb more incomplete in

the female, and the glandular areas on the sternites of the male are oblong. By contrast *cinctipennis* has only a faint brown band on antennal segment III, the dark band at the tip of the fore wing is smaller, abdominal tergite VIII has the posterior comb more complete, and the glandular areas on the sternites of the males are small and oval. Hood (1912c) in his original description, allied *cinctipennis* to *fasciapennis*, but the latter species has three dark bands on the fore wing in addition to the spot at the base whereas *cinctipennis* and *fasciatus* have only two dark crossbands on the fore wings in addition to the spot at the base.

Illinois records.—Collected from April to late October, from one to several localities in the following counties: ADAMS, CARROLL, CHAMPAIGN, CLAY (Hood 1912c), COLES, HARDIN, HENDERSON, JACKSON, JOHNSON, LAWRENCE, MASON, MONROE, PIKE, POPE, SALINE, TAZEWELL, UNION, and VERMILION.

***Caliothrips fasciapennis* (Hinds)**

Heliothrips fasciapennis Hinds (1902: 171). ♀. Type-locality.—Amherst, Massachusetts. Transferred to *Hercothrips* by Hood (1927d). Transferred to *Caliothrips* by Faure (1962).

FEMALE (macropterous).—Length distended about 1.3 mm. General color blackish brown. Dark brown: most of insect. Yellow to nearly white: legs except middle of femora and tibiae, antennal segments III and IV and base of V. Fore wing with three crossbands in addition to the dark spot at the base of the wing. Sides of abdomen more or less hexagonally reticulate. Posterior margin of abdominal segment IX on dorsum with an incomplete comb somewhat as in *fasciatus*. Without heavy black spines in the middle of the fore wings.

MALE (macropterous).—Length distended about 0.9 mm. Colored as in female. Abdominal sternites III–VII each with a wide, transverse, oblong glandular area.

This species is widespread in the eastern half of the United States,

ranging from Massachusetts to eastern Kansas and south into Florida (USNM records) and Arkansas (INHS records). What is considered *fasciapennis* in the western states may be a different species or subspecies. In Illinois it does not extend as far north as does *cinctipennis*. As is the case in *cinctipennis*, *fasciapennis* lives in grasslands and sometimes both species occur together. Almost nothing is known of the life history of *fasciapennis*. Males are scarce, and the larvae and pupae have not been described as yet.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, CLARK, CLINTON, GALLATIN, JEFFERSON, JACKSON (USNM), JOHNSON, MARION, PIATT, PIKE, POPE, PULASKI (USNM), and UNION.

***Caliothrips fasciatus* (Pergande)** Bean Thrips

Heliothrips fasciata Pergande (1895: 391). ♀. Type-locality.—Marysville, Yuba County, California. Transferred to *Hercothrips* by Hood (1927d). Transferred to *Caliothrips* by Faure (1962).

Caliothrips woodworthi Daniel (1904: 297). ♂ (erroneously listed as ♀). Synonymized by Moulton (1907).

FEMALE (macropterous).—Length distended about 1.4 mm. Body dark brown. All of coxae, median portions of femora, and tibiae concolorous with body; all tarsi and extremities of the femora and tibiae light yellow. Antennal segments I, II, and VI–VIII dark brown; median portions of segments III and IV and apex of V brown. Rest of antennae light yellow. Wings pale gray with two dark crossbands, not dark at base. Body setae generally yellow.

Head wider than long, cheek outline slightly depressed in the middle; dorsal surface with hexagonal reticulations, each reticule subdivided by fine lines. Ocellar triangle located midway between eyes. Interocellar setae small; postocular setae fairly well developed, pale in color. Mouth cone long, blunt-

ly rounded. Maxillary palps each two segmented.

Antennal segments—I quadrate; II ovoid, pedicellate, widest; III and IV strongly vasiform, each with forked sense cones; V clavate; VI urn shaped; VII and VIII tubular, closely joined.

Prothorax wider than long, hexagonally reticulate, with each reticule subdivided by fine lines. Setae colorless. Mesoscutum and metascutum hexagonally reticulate, with each reticule subdivided by fine lines.

Fore wings without any especially enlarged venal setae.

Abdomen with most tergites bearing subdivided reticulate sculpture laterally. Tergite VIII with only lateral portions bearing toothlike projections. Abdominal tergite X split for nearly the entire length.

MALE (macropterous).—Length distended about 1.1 mm. Similar to female in color and structure. Abdominal sternites III–VII inclusive each with a small, elliptical, median glandular area. Abdominal tergite IX, on the median posterior portion, with two pairs of small, stout spines.

This species was found once in Illinois. Apparently it is an adventive species and has never become established here. Because it might be imported again, and even become a greenhouse pest in our state, it is included here and in the key.

In form and color *fasciatus* resembles *cinctipennis*. The two can be separated by the characteristics mentioned in the key and in the discussion of *cinctipennis*.

In the West this thrips lives on the leaves on many weeds and cultivated plants. Its preferred host appears to be wild lettuce (*Lactuca scariola*). Russell (1912) and Bailey (1933) have studied phases of its life history in detail. It is the only *Caliothrips* whose biology is reasonably well known.

Another unrelated species, *phaseoli*, which also damages beans, should not be confused with *fasciatus*. *Caliothrips phaseoli* seems to be limited in its range to the southern and southwestern states.

Illinois record.—CHAMPAIGN COUNTY: Urbana, March, 1907, Davis, on

California oranges, 1 ♀, 2 ♂. Reported by Russell (1912); slides in USNM.

Caliothrips phaseoli (Hood)

Heliothrips phaseoli Hood (1912b:113).

♀, ♂. Type-locality.—Brownsville, Texas. Transferred to *Hercothrips* by Hood (1927d). Transferred to *Caliothrips* by Faure (1962).

Heliothrips gossypii Moulton (1927a:32). ♀, ♂. Type-locality.—Phoenix, Arizona. Synonymized by Hood (1940b).

FEMALE (macropterous).—Length distended about 1.1 mm. General color brown. Head becoming yellowish brown to yellow anteriorly; legs brown except each of the femora at either extremity and all tarsi which are yellow. Antennal segments—I pale at base, brown apically; II and VI–VIII brown; III–V pale yellow basally, brown apically. Fore wings white with brown bands, brown at extreme base, a broad brown band in the middle and at the apex; setae in region of brown bands generally brown, those in white areas generally clear. All body setae yellow to colorless.

Head much wider than long, cheek outline slightly depressed in the middle; dorsal surface with transverse, elongate, hexagonal reticulations, with each reticule, except those in the posterior rows, subdivided by fine lines; ventral surface more or less smooth. Ocellar triangle midway between fore and hind margin of eyes. Interocellar and postocular setae fairly well developed, difficult to see because of pale color. Mouth cone long, about as long as dorsal length of head, bluntly rounded. Maxillary palps each two segmented, labial palps each seemingly one segmented.

Antennal segments—I quadrate; II ovoid, pedicellate, widest; III and IV vasiform, each with forked sense cones; V clavate; VI urn shaped; VII tubular; VIII long and slender.

Prothorax nearly as long as head; dorsal surface with transverse, elongate reticulations which are subdivided by fine lines, except for a few clear reticules on either side of the

middle; with a few scattered, moderately developed, clear setae.

Pterothorax ovoid in outline, broadest part of body. Metascutum hexagonally reticulate, with reticules, in the midregion, subdivided by fine lines.

Fore wings without any especially enlarged venal setae.

Legs moderately slender; tarsi one segmented.

Abdomen with most tergites bearing transverse lines at side, not hexagonally reticulate. Abdominal segment VIII with only extreme lateral portion bearing toothlike projections. Abdominal tergite X weakly split at or near extreme apex.

MALE.—None present in collections of Illinois Natural History Survey. Prologist reports length about 0.77 mm. Abdominal sternites III–VII each with a transverse glandular area. Abdominal tergite IX with two pairs of short, stout spines.

Caliothrips phaseoli is distinguishable from any congener likely to be present in Illinois by the characteristics mentioned in the accompanying key.

This thrips has been reported to be a pest of beans (Hood 1912*b*) and possibly cantaloupe (Bailey 1957). Until recently it was known by a few records from Tamaulipas (Mexico), Texas, Arizona, and California. A previously unrecorded specimen in the INHS collection from Monticello, Florida, collected on clover by Dr. G. C. Decker, February 23, 1956, indicates that this potentially injurious species is more widespread than previously thought. It may yet be found in Illinois.

***Caliothrips striatus* (Hood)**

Heliothrips striatus Hood (1913c:309).

♀, ♂. Type-locality.—Chevy Chase Lake, Maryland. Transferred to *Hercothrips* by Hood (1927*d*). Transferred to *Caliothrips* by Faure (1962).

Heliothrips fasciatus Pergande (Morgan, in Russell 1912). Misidentification according to Hood (1917).

FEMALE (macropterous).—Length distended about 1.3 mm. General color

blackish brown. Legs pale yellow to yellow at the extremities of the tibiae and all of the tarsi, spot on either side of the ocelli paler yellow to yellow, antennal segments III and IV in the basal half and all of segment V pale gray. Fore wing with a dark crossband at the apex and another dark crossband occupying the middle portion. Head and prothorax as in Fig. 104. Sides of abdomen on the dorsum striate rather than hexagonally reticulate.

MALE (macropterous).—Length distended about 0.9 mm. Similar to female in general color and structure. Abdominal sternite VI with a small, circular glandular area; VII with a narrow, transverse, median glandular area (Hood, in 1913, stated that glandular areas were present on segments III–V as well, but none are visible on these segments on specimens I have observed from Illinois and Kentucky). Abdominal tergite IX with two pairs of short, stout spines.

This distinctive species can be dis-

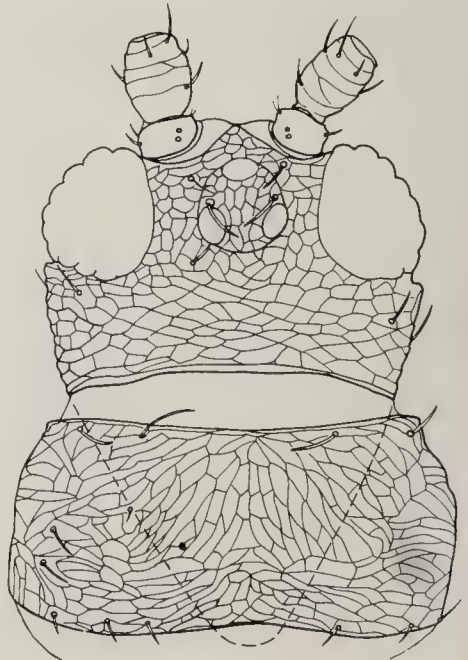


Fig. 104.—*Caliothrips striatus*, head and prothorax, wrinkles within reticules not shown.

tinguished easily from its Illinois congeners by the form of striations on the sides of the abdominal tergites which are arranged in parallel rather than in hexagonal designs, and by the presence of two heavy black setae in the middle of the fore wing.

Hood (1913c) reported this species from Parker, Illinois. The same author recorded it also from Maryland (1913) and from Virginia (1917). Morgan, in Russell (1912), recorded *striatus*, erroneously determined as *fasciatus*, from Tennessee, and I have examined a specimen from the Great Smoky Mountain National Park of Tennessee. Recently Wray (1950) listed this species from North Carolina. There are many specimens from Florida, also, in the U.S. National Museum. Apparently its preferred host is the tulip tree (*Liriodendron tulipifera*).

Illinois records (Fig. 22).—CLARK COUNTY: Clarksville (Rocky Branch), July 6, 1961, Stannard, on leaves of *Liriodendron*, 2 ♀. JACKSON COUNTY: Giant City State Park, June 25, 1958, Dybas, Stannard, 1 ♀; Gorham (Fountain Bluff), June 22, 1958, Dybas, Stannard, on leaves of *Liriodendron*, 2 ♀; Murphysboro (Little Grand Canyon), August 13, 1964, Faatz, Stannard, on leaves of *Liriodendron*, 1 ♀, 1 ♂. JOHNSON COUNTY: Parker, July 14, 1909, Hart, on leaf of *Liriodendron tulipifera*, 1 ♀ (USNM). MASSAC COUNTY: Brookport, May 25, 1967, Stannard, on leaf of *Liriodendron*, 2 ♀. POPE COUNTY: Bell Smith Springs Recreation Area, June 24, 1958, Dybas, Stannard, on leaf of *Liriodendron*, 1 ♀; Eddyville (Hays Creek Canyon), August 26, 1964, Faatz, Stannard, on leaves of *Liriodendron*, 2 ♀, 3 ♂. UNION COUNTY: Don-gola, July 15, 1954, Ross, Stannard, on leaves of *Liriodendron*, 1 ♀, 1 ♂.

Chaetanaphothrips Priesner

Anaphothrips subgenus *Chaetanaphothrips* Priesner (1926b:204). Type-species by monotypy.—*Euthrips orchidii* Moulton. Raised to full generic rank by Bagnall (1926a).

Head broader than long, *Sericothrips*-like in appearance. Antennae

eight segmented; segments III and IV each with a long, forked sense cone; two segmented style, long and slender. Mouth cones short and broadly rounded. Maxillary palps three segmented.

Prothorax with one or two pairs of epimeral setae well developed, when two developed the inner pair is the larger. Midanterior prothoracic setae relatively small but larger than adjacent setae. Mesospinasternum separated from metasternum by a suture. Fore legs not enlarged. All tarsi two segmented. Wings narrow, the two principal veins sparsely setose; fringe cilia wavy.

Abdomen with median pair of setae placed far apart on intermediate tergites. Abdominal sternites without accessory setae in addition to posterior ones. Posterior margins of abdominal sternites with large, flat platelets. Abdominal tergite VIII with posterior comb of setae incomplete, limited to several setae on either side. Stippled area around spiracles on abdominal tergite VIII extended up to the anterior margin (Fig. 96). Females with or without elliptical glandular area on abdominal sternite VII. Males with abdominal sternites III–VII with elliptical glandular areas. Males with four thornlike setae on abdominal tergite IX.

This genus can be easily and immediately recognized by the large stipple-like areas on abdominal tergite VIII, a condition not found elsewhere in the Terebrantia except in *Prosopothrips*. Of the half dozen or so species currently assigned to *Chaetanaphothrips* only *orchidii* is found in Illinois.

Chaetanaphothrips orchidii (Moulton)

Euthrips orchidii Moulton (1907:52). ♀. Type-locality.—Fruitvale, Alameda County, California; in greenhouse. Provenience unknown. Placed in *Chaetanaphothrips* by Priesner (1926b).

FEMALE (macropterous).—Length distended about 1.3 mm. Color generally pale yellow, head and thorax brighter yellow. Brown: antennal seg-

ment IV at extreme apex, segment V in apical one-third, segment VI in apical half, and all of segments VII and VIII; base of fore and hind wings, a broad band in the middle of the fore wing, and a narrow band in the middle of the hind wing. Ocellar pigment red.

Head without setae close to fore ocellus.

Prothorax with two pairs of epimeral setae well developed, the inner pair the larger.

Abdominal sternite III without glandular area. Abdominal tergite VIII usually with lateral stipuled areas not as extended towards the meson along the base as in *signipennis* (Fig. 96).

MALE.—Unknown.

LARVA.—Described in the Czechoslovakian language and illustrated by Pelikán (1954).

This species has been the subject of controversy. Hood (1954*b*) sank the name *signipennis* under *orchidii* for the reason that both entities can be found on bananas. Hood explained away the morphological differences between the two entities on the presumption that one was a diploid and the other a haploid form, apparently without any cytological evidence (at least no such evidence was presented).

In my opinion *orchidii* is a new-world thrips. It is distinct from the old-world banana thrips, *signipennis*, in several morphological characteristics. The two species are now distributed throughout the tropics and subtropics and in northern greenhouses, probably by the agency of man. Out-of-door populations of the species *orchidii* extend into the temperate region in North America. I am unable to disprove or prove, at present, whether or not one is diploid and the other is haploid or whether one is a form of the other. By itself, the fact that both species have been found on bananas is not proof of anything.

The following characteristics distinguish *signipennis* from *orchidii*. *Chaetanaphothrips signipennis*.— 1) Fore ocellus with a pair of setae, one close to either side of this ocellus. 2) Abdominal sternite III of female with an elongate transverse glandular area.

3) Outer epimeral pair of setae minute. *Chaetanaphothrips orchidii*.— 1) Fore ocellus with no setae immediately close. 2) Abdominal sternites of female without a glandular area. 3) Outer epimeral pair of setae larger.

Pelikán (1954) has given an account of the life history of *orchidii*. I have not read this work as yet because it is written in Czech, a language not familiar to me. As usual, Dr. Pelikán's treatment is well illustrated and an English summary is included.

Although *orchidii* was formerly considered a tropical thrips confined to greenhouses in northern regions (Pelikán 1954), apparently natural populations of it occur out-of-doors in Illinois. Five collections have been taken in Illinois several miles from the nearest greenhouses. Elsewhere I have taken specimens from native herbs in Key West, Florida, and several localities in southern Mexico. This species also has been found out-of-doors in California and Louisiana (USNM records).

In the Far South these thrips have been reported to cause damage to mature grapefruit (Thompson 1939).

Illinois records.—CLINTON COUNTY: Carlyle, August 15, 1951, Ross, Stannard, on dead branch, 1 ♀. GREENE COUNTY: Eldred, June 7, 1949, Sanderson, Stannard, sweeping herbs in woodland, 1 ♀. HANCOCK COUNTY: Nauvoo, July 25, 1957, Evers, Stannard, forest, 1 ♀. HENDERSON COUNTY: Oquawka, September 8, 1947, Ross, Stannard, sweeping herbs in woodland, 3 ♀. MONROE COUNTY: Valmeyer, July 19, 1948, Smith, Stannard, sweeping herbs in woodland, 1 ♀.

Chilothrips Hood

Chilothrips Hood (1916*d*:119). Type-species by original designation.—*Chilothrips pini* Hood.

Head broad. Eyes proportionately small. Antennae eight segmented. Antennal segments III and IV with forked sense cones. Mouth cones greatly enlarged and drawn out (Fig. 105). Maxillary palps three segmented, labial palps two segmented.

Chilothrips pini Hood

Chilothrips pini Hood (1916d:120). ♀.
Type-locality.—Bladensburg,
Maryland.

FEMALE (macropterous).—Length distended nearly 2 mm. Color almost uniformly light brown. Body with much orange-yellow subsintegumental pigment. Ocellar pigment red.

Head (Fig. 105) much wider than long. Antennal segment VI with an impression or line suggestive of a primigenial suture on ventral surface near apex.

Prothorax with three pairs of minor posterior setae between the well-developed epimeral pair. Fore tarsi each without apical claw.

Abdominal sternites with accessory setae in addition to posterior ones.

MALE.—Unknown.

This species has not as yet been taken in Illinois, but it may be present in southern Illinois on the few remaining yellow pines in the Wolf Lake region or in northern Illinois on white pines. Dr. W. Suter has found it near Friendship, Adams County, Wisconsin about 100 miles north of the Illinois border (INHS records).

In the INHS collection there are specimens taken in winter from the duff and needles under *Pinus virginiana* at Silver Springs, Maryland, about 5 miles in a direct line from Bladensburg, the type locality of the species. Fig. 105 was drawn from these specimens.

Chirothrips Haliday

Thrips subgenus *Chirothrips* Haliday (1836:444). Type-species by monotypy.—*Thrips (Chirothrips) manicata* Haliday. Raised to full generic rank by Amyot and Serville (1843).

Head small, prolonged slightly to considerably beyond eyes. Eyes proportionately large. Ocelli always present in females, absent in males so far as is known, located on the posterior half of the head. Antennae eight segmented, segment I usually enlarged, segment II produced at outer apex, last two segments forming a style. An-

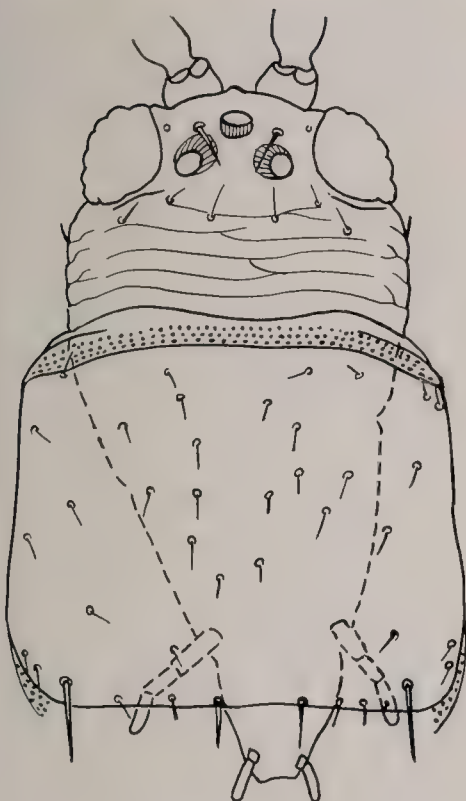


Fig. 105.—*Chilothrips pini*, head and prothorax.

Prothorax long, only one pair of epimeral setae well developed (Fig. 105). Mesospinasternum separated from metasternum by a suture. Fore legs not enlarged. All tarsi two segmented. Fore wings with two veins, setae on fore vein interrupted, setae on hind vein uniformly spaced; fringe cilia wavy.

Abdomen with pleural plates. Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal tergite VIII without posterior comb of setae. Males unknown.

The sole species of this genus is *Oxythrips*-like in all respects except in the form of the mouth cone. In *Chilothrips* the mouth cone is heavy and long, whereas in *Oxythrips* the mouth cone is short—as short as that found in *Anaphothrips* or most other genera in the Thripidae.

tennal segment III with sense cones simple, segment IV with cones simple or forked. Maxillary palps three segmented, labial palps two segmented.

Prothorax trapezoidal (Fig. 106). Epimeral setae usually well developed. Area forward of probasisternum triangular, composed of short, straight striae. Mesospinasternum separated from metascutum by a wide suture. Fore legs enlarged. All tarsi two segmented. Females macropterous, males apterous or brachypterous. Fore wings with two veins, setae on both veins interrupted; fringe cilia wavy.

Abdomen with pleural plates. Tergites and sternites without microsetae. Abdominal tergites without posterior combs of setae, abdominal sternites without accessory setae in addition to the posterior ones. Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal tergite X of female with a full longitudinal split. Males with or without sternal glandular areas.

The trapezoidal shape of the thorax, the small head, the produced apex of antennal segment II, and the enlarged fore legs are in combination characteristics unique to the species in this genus.

More than a third of the eastern and southern species occur in Illinois. All feed primarily on grasses. Apparently some of the species are far-ranging in their distribution, as for example, *mexicanus*, which is found from Guadalajara, Mexico, to southern Illinois and as a vagrant into South America, Hawaii, and the Philippines, or as another example, *falsus*, which occurs from Mexico to Canada.

In 1939 both Hood and Andre wrote on *Chirothrips* and separately came to the same conclusions on the synonymy of several species. Andre gave a comprehensive treatment and included a key to all North American species. Hood dealt only with species that had synonymy. By coincidence both of these authors described the same species as new. Andre's names, *texanus* and *sensitivus*, have priority by several months over *auriventris* Hood and *talpoides* Hood.

An analysis and key of the Palearctic

species was given by Priesner (1949). A catalogue and key to all the known species was prepared by Zur Strassen (1960a).

KEY TO SPECIES

(UNITED STATES, KEY TO
ADULTS, EAST OF 100TH MERIDIAN)

(Females only, many males unknown, *lenape* Hood of New Jersey also not included)

1. Mesonotum and metanotum with numerous short, stout setae 2
Mesonotum and metanotum without numerous short, stout setae, with only the normally few pairs 4
2. Head with 15-18 pairs of short, stout setae on the vertex *vestis*
Head with more than 20 pairs of stout setae on vertex 3
3. Head with 24-27 pairs of short, stout setae on the vertex; as yet known only from Texas *dorsalis*
Head with 34-44 pairs of short, stout setae on the vertex; widespread *texanus*
4. Antennal segment I enlarged 5
Antennal segment I not enlarged 10
5. Head with five or more pairs of short, stout setae on the vertex 7
Head with three pairs of setae on vertex 6
6. Most abdominal tergites with a line of heavy scallops; abdominal sternites usually covered with heavy scallops *mexicanus*
Most abdominal tergites with a line of minute scallops; abdominal sternites transversely striate *crassus*
7. Head with five to six pairs of setae on vertex *crenulatus*
Head with seven or more pairs of setae on vertex 8
8. Head with seven to nine pairs of setae on vertex *spiniceps*
Head with 12 or more pairs of setae on vertex 9
9. Head with 12-14 pairs of setae on vertex; known only from Florida *sensitivus*
Head with 20-24 pairs of setae on vertex *fulvus*
10. Head with five or six pairs of setae on vertex; not yet found in Illinois *productus*
Head with three pairs of setae on vertex 11
11. Antennal segment II scarcely produced at apex 12
Antennal segment II well produced at apex 13
12. Interocellar setae placed far forward of fore ocellus, stout *falsus*
Interocellar setae placed just slightly in advance of fore ocellus, slender; known only from New York (Hood 1940c) and Maine (USNM records) *patruelis*
13. Antennal segment II with produced apex broadly rounded and with apical setae arising from concave area below the tip; from New York (Hood 1940c) and

- Minnesota (USNM records).....**cuneiceps**
 Antennal segment II with produced apex
 more or less pointed.....14
 14. Antennal segment VI about equal in
 length to the combined length of seg-
 ments IV and V.....**insolitus**
 Antennal segment VI much shorter than
 the combined length of segments IV
 and V.....15
 15. Antennal segment II with a thickened
 ridge on inner side.....16
 Antennal segment II without a thickened
 ridge on inner side.....17
 16. Abdominal sternites with toothlike pro-
 jections laterally; from the Great
 Plains, not likely to be found in Illi-
 nois.....**alexandrae**
 Abdominal sternites without toothlike
 projections.....**praeocularis**
 17. Head greatly prolonged, production about
 equal to cheek length; not yet found in
 Illinois.....**bradleyi**
 Head not as greatly prolonged.....**manicatus**

Chirothrips crassus Hinds

Chirothrips crassus Hinds (1902:136).
 ♀, ♂. Type-locality.—Amherst,
 Massachusetts.

Chirothrips obesus Hinds (1902:137).
 ♀. Type-locality.—Amherst, Mas-
 sachusetts. Synonymized by Hood
 (1939b).

Chirothrips obesus var. *hubbelli* Wat-
 son (1926a:58). ♀. Type-locality.—
 Dixie County, Florida. Synony-
 mized by Hood (1939b).

FEMALE (macropterous).—Length
 distended slightly over 1 mm. Bicol-
 ored brown and yellow. Brown: head,
 thorax, and abdominal segment I; an-
 tennal segments III–VIII, lightest in
 segment III; most of fore femora and
 sides of legs. Fore wings light brown
 except a nearly white band just be-
 yond scale. Rest of body yellow except
 sometimes abdomen yellowish brown.
 Body with yellow to red subintegu-
 mental pigment. Ocellar pigment
 bright red.

Head with three pairs of setae on
 vertex. Interocellar setae placed far
 forward of fore ocellus. Antennal seg-
 ment I enlarged, segment II greatly
 produced at apex, segment VI and
 style (segments VII and VIII) espe-
 cially long.

Thorax without stout notal setae.
 Pronotum with epimeral setae ex-
 tremely small. Prosternum without

setae. Mesoscutum with striae
 straight, only slightly suggestive of
 scallops. Anterior margin of meso-
 sternum with about 20 slender setae.

Most abdominal tergites with a line
 of minute scallops. Abdominal ster-
 nites with transverse striae.

MALE (apterous).—Length dis-
 tended about equal to female. Bicol-
 ored brown and yellow but differently
 than in female. Brown: head, antennal
 segments III–VIII (segments III and
 IV lightest), prothorax, much of the
 legs, abdominal segments V (light)
 and VI–X (dark).

Similar to female in general struc-
 ture. Ocelli lacking. Abdominal ster-
 nites III–VII each with an oval glan-
 dular area of moderate size.

As a short, stout member of *Chiro-
 thrips*, this species well deserves its
 now synonymous name, *obesus*.

Chirothrips crassus has been re-
 corded from Massachusetts to Florida
 westward to Tennessee, Illinois, and
 Iowa. In Illinois we have found that
 the species occurs, locally abundant,
 throughout the state. We have taken
crassus as far west as Rogers in north-
 western Arkansas.

Illinois records.—Collected during
 every season of the year, from one to
 several localities in the following coun-
 ties: ADAMS, ALEXANDER, CHAM-
 PAIGN, CLARK, CLINTON, COOK, HEN-
 DERSON, JACKSON, LAWRENCE, MAR-
 ION, MASON, POPE, ROCK ISLAND, and
 WAYNE.

Chirothrips crenulatus Hood

Chirothrips crenulatus Hood (1927a:
 130). ♀. Type-locality.—Boulder,
 Colorado.

FEMALE (macropterous).—Length
 distended about 1.6 mm. General col-
 or brown, abdomen sometimes lighter
 brown than rest of body; apex of an-
 tennal segment II and all tarsi yellow.
 Fore wings grayish brown except for
 subbasal band which is pale gray.
 Body, especially in the abdomen, with
 orange to red subintegumental
 pigment.

Head moderately prolonged in front
 of eyes. Vertex with four to six pairs of
 stout setae. Interocellar setae placed
 nearly opposite fore ocellus. Antennal

segment I enlarged, segment II greatly produced at apex, segments III and IV with simple sense cones, segment VI much shorter than the combined length of segments IV and V.

Pronotum moderately setose, setae not as stout as those on vertex of head, with two pairs of moderate-sized posterolateral setae. Mesonotum with only the few normal setae, scalloped anteriorly and along extreme posterior margin. Prosternum without setae. Metanotum with only the few normal setae, with broken reticulations. Mesosternum and metasternum with many stout setae.

Abdominal tergites, except on terminal segments, with one to several lines of minute scallops subbasally. Abdominal sternites, except terminal ones, with large scallop-like markings. Abdominal segment X moderately short.

MALE (apterous).—Length distended about 1.2 mm. Lighter brown than female, pterothorax and abdominal segments I–VII yellowish brown to yellow. Structure similar to female except ocelli lacking, prothorax less setose, posterolateral pairs of setae much reduced, wings lacking except occasionally a minute pad. Abdominal sternites III–VII each with a median glandular area of moderate size.

This species is readily distinguished by the feature of five to six pairs of setae on the vertex of the head and by one to several lines of minute scallops on the anterior region of most of the abdominal tergites.

Although known only from Colorado, Nebraska, and Kansas, there is a possibility that *crenulatus* may be found eventually on some of the hill prairies or sand prairies in Illinois. Specimens have been taken as far east as Lincoln, Nebraska (Hood 1927a) and Junction City, Kansas (INHS records).

***Chirothrips falsus* Priesner**

Chirothrips falsus Priesner (1925d: 312). ♀. Type-locality.—One of several localities in Mexico. Andre (1939:195). ♂.

Chirothrips falsus var. *adusta* Priesner (1925d:313). ♀. Type-locality.—One of several localities in Mexico. Synonymized by Hood (1939b).

Chirothrips simplex Hood (1927a:128). ♀. Type-locality.—Denver, Colorado. Synonymized by Andre (1939) and Hood (1939b).

FEMALE (macropterous).—Length distended about 1.5 mm. Color entirely dark brown. Thorax with orange subintegumental pigment. Ocellar pigment red. Fore wings brown.

Head hardly at all prolonged beyond eyes, with few dorsal setae, one pair of which is stout. Antennal segment I small; segment II slightly produced at outer angle, produced tip broadly rounded.

Thorax without stout setae. Pronotum with two pairs of prominent epimeral setae. Mesoscutum with striae not scalloped. Anterior margin of mesosternum with about 16 short, slender setae.

Abdominal tergites without scallops. Abdominal sternites with transverse striae.

MALE (brachypterous).—Length distended less than 1 mm. Similar to female in color but sometimes, possibly because of a teneral condition, abdominal segments II–VIII yellowish brown. Ocelli lacking. Similar to female in general structure. Abdominal sternites III–VIII each with small, circular, glandular area.

According to Hood (1927a) this species was first collected in Illinois by Charles Hart in 1908 from Havana, a sandy area which supports many western and southern relics. We have since taken *falsus* in Illinois on western hill prairies.

Illinois records.—MASON COUNTY: Forest City, September 11, 1953, Ross, Stannard, sand prairie, 1 ♂. PIKE COUNTY: Atlas, August 12, 1948, Sanderson, Stannard, sweeping grass on hill, 1 ♂; New Canton, August 13, 1948, Stannard, hilltop prairie, 4 ♀, 2 ♂. UNION COUNTY: Wolf Lake, April 9, 1953, Stannard, on *Panicum vergatum*, 1 ♀.

***Chirothrips fulvus* Moulton**

Chirothrips fulvus Moulton (1936b: 182). ♀, ♂. Type-locality.—Paumotu, Oahu, Hawaii.

FEMALE (macropterous).—Length distended about 1.6 mm. General color yellowish brown, darkest in the head. Antennal segments I–III brownish yellow, the remainder of the antennae light brown. All tarsi yellow. Fore wings light brown except for a subbasal band which is nearly colorless. Ocellar pigment red.

Head considerably prolonged, distance from the anterior corner of the eye to the outer base of the antenna equal to the distance from the posterior margin of the head to the posterior corner of the eye. Vertex with 20–24 pairs of setae. Interocellar setae placed opposite fore ocellus. Antennal segment I enlarged, segment II greatly produced at apex, segments III and IV with simple sense cones, segment VI much shorter than the combined length of segments IV and V.

Prothorax moderately setose, setae not especially stout, with two pairs of posterolateral setae of moderate size. Mesonotum with only the few normal setae, with scallop-like sculpture. Metanotum with only the few normal setae, hexagonally reticulate. Mesosternum and metasternum with many setae. Fore legs greatly enlarged. Abdominal sternites and tergites with scallop-like sculpture. Abdominal segment X short.

MALE (brachypterous).—Length not distended about 1 mm. General color yellow except head, antennal segments III–VIII, and sides of abdominal segment IX, which are light brown. Similar to female in structure except head with vertex bearing 17–20 pairs of setae, ocelli lacking, wings reduced to tiny pads. Abdominal sternites III–VII each with a circular, median glandular area of moderate size.

Although described as having 15–17 pairs of head setae, the two paratypes of this species that I have examined had 20–22 pairs of vertex setae in the female specimen and 17–20 pairs in the

male specimen. A Tennessee specimen in the INHS collection bears 24 pairs of vertex setae.

In North America, *Chirothrips fulvus* stands between *vestis* and *dorsalis* in the number of head setae. The Russian *spinulosis*, however, bears the same number of vertex setae as does *fulvus*. From all of these aforementioned species, *fulvus* differs in lacking numerous stout setae on the mesothoracic and metathoracic nota.

Despite the fact that *fulvus* was first discovered in Hawaii, this species is most likely a native of North America. Hood (1939b) recorded it from Palacios, Texas, and there is in the INHS collection a specimen from Paris, Tennessee, a locality less than 60 miles south of the Illinois border. Almost certainly this species will be found eventually in Illinois.

***Chirothrips insolitus* Hood**

Chirothrips insolitus Hood (1915a:11). ♀. Type-locality.—Four Mile Run, Virginia.

FEMALE (macropterous).—Length distended over 1.5 mm. Color almost entirely dark brown except tarsi yellowish brown. Fore wings light brown, lightest subbasally. Thorax with orange to red subintegumental pigment. Ocellar crescents deep red.

Head with few dorsal setae. Antennal segment I small, segment II only moderately produced at outer apical angle, segment VI and style (segments VII and VIII) unusually long.

Prothorax with slender, short setae; with two pairs of long epimeral setae. Anterior half of mesocutum with scallops. Anterior margin of mesosternum with about 16 slender setae.

Except segment I, abdominal tergites without a scalloped transverse line. Abdominal sternites with transverse striae becoming scalloped but not as definite as in *mexicanus*.

MALE. Unknown.

This species is distinctive by the features of the small first antennal segment, the long sixth antennal segment, the lack of a transverse scalloped line

on any of the abdominal tergites except somewhat on segment I, and by the incipient scallops on the abdominal sternites. By certain combinations of characteristics, *insolitus* is intermediate between *manicatus* and *mexicanus*.

Apparently the southern fourth of Illinois constitutes the limit of the northward distribution of this species.

Illinois records.—GALLATIN COUNTY: Gibsonia, April 5, 1948, Burks, Stannard, grass, 1 ♀. HARDIN COUNTY: Karbers Ridge (High Knob), August 18, 1950, Stannard, *Andropogon*, 18 ♀. JACKSON COUNTY: Giant City State Park, June 25, 1958, Dybas, Stannard, grass, 1 ♀; Makanda, July 14, 1948, Sanderson, Stannard, grass, 1 ♀; Murphysboro, September 21, 1949, Smith, Stannard, hilltop prairie, 3 ♀. WASHINGTON COUNTY: New Minden, June 4, 1957, Stannard, on wild rose, 1 ♀.

***Chirothrips manicatus* Haliday**

Thrips (Chirothrips) manicata Haliday (1836:444). ♀. Type-locality.—England. Raised to full generic rank by Amyot and Serville (1843). Uzel (1895:83). ♂.

Thrips longipennis Burmeister (1838:413). ? ♀. Type-locality.—Probably Berlin, Germany. Synonymized by Uzel (1895).

Chirothrips antennatus Osborn (1883:154). ♀. Type-locality.—Manchester, Iowa. Synonymized by Uzel (1895).

Pezothrips (?) pedestris Karny (1910:55). ♂. Type-locality.—Neustift, Austria. Synonymized by Priesner (1926b). Recognized as a possible distinct species by Zur Strassen (1960a).

FEMALE (macropterous).—Length distended about 1.5 mm. Color almost entirely dark brown; antennal segment III, tarsi, and fore wings lighter brown. Hind wings pale gray except extreme base which is light brown. Ocellar crescents red. Body with red subintegumental pigment.

Head moderately prolonged beyond eyes, with few dorsal setae. Antennal segment I not greatly enlarged; seg-

ment II produced at outer angle, produced tip acute. Segment VI and style (segments VII and VIII) not unusually long.

Thorax without stout setae. Pronotum with two pairs of prominent epimeral setae. Mesoscutum with anterior striae scalloped. Anterior margin of mesosternum with about 16 short, slender setae.

Abdominal tergites without scallops. Abdominal sternites with transverse striae, except posterior line which is scalloped.

MALE (brachypterous).—Length distended nearly 1.2 mm. Similar to female in color but somewhat lighter. Antennal segments II and III and tarsi yellowish brown. Ocelli lacking. Wings reduced to tiny fore wing pads. Similar to female in general structure. Abdominal sternites III–VII each with an oval glandular area.

Presumably this species was introduced into eastern North America from Europe. Osborn was probably the first entomologist to observe it in America when in July 1882 he found *antennatus* (= *manicatus*) abundant in Iowa in heads of timothy grass.

Although most common in pastures, hayfields, and roadsides where the natural flora has been disturbed by man, *manicatus* also has successfully invaded native prairie habitat.

It has not been taken in the southern third of Illinois.

Illinois records. (Fig. 17).—Collected every season of the year, from one to several localities in the following counties: ADAMS, BUREAU, CARROLL, CHAMPAIGN, CLARK, COOK, DU PAGE, EDGAR, EFFINGHAM, FORD, HENDERSON, IROQUOIS, KANE, KENDALL, LAKE, LAWRENCE, LEE, MASON, MCHENRY, MCLEAN, MERCER, OGLE, PEORIA, PIATT, PIKE, PUTNAM, STARK, STEPHENSON, VERMILION, WARREN, WILL, and WINNEBAGO.

Chirothrips mexicanus

Crawford, D. L.

Chirothrips mexicanus Crawford, D. L. (1909:114). ♀. Type-locality.—Guadalajara, Mexico. Moulton (1928:106). ♂.

Chirothrips floridensis Watson (1920: 21). ♀. Type-locality.—Seabreeze, Florida. Synonymized by Andre (1939) and Hood (1939b).

Chirothrips floridensis var. *catchingsi* Watson (1924a:76). ♀. Type-locality.—New Orleans, Louisiana. Synonymized by Hood (1927b).

FEMALE (macropterous) (Fig. 106).—Length distended about 1.5 mm. Color generally dark brown, antennal segments II and III lighter brown, fore femora and all tarsi yellow to yellowish brown, fore wings light brown. Ocellar pigment bright red.

Head with three pairs of stout setae

on vertex. Antennal segment I greatly enlarged, segment II considerably produced at outer apical angle, segment VI and style (segments VII and VIII) not especially long.

Pronotum with slender, short setae; with two pairs of epimeral setae. Prosternum without setae. Anterior half of mesoscutum with scallops. Mesonotum and metanotum with only the few normal setae. Anterior margin of mesosternum with 50 or more stout setae.

Abdominal tergites I–VI with a transverse line of scallops. Abdominal sternites II–V with scallop-like striae.

MALE (?apterous).—Length given

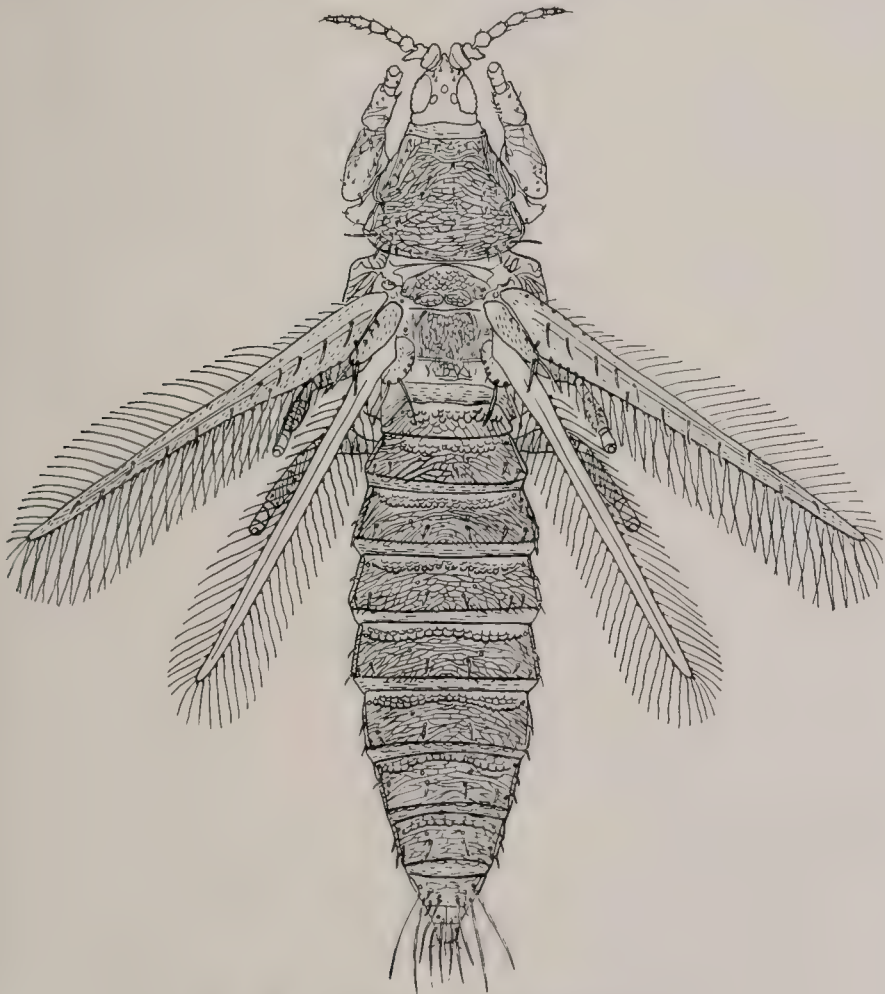


Fig. 106.—*Chirothrips mexicanus*, dorsal aspect.

by Moulton (1928) as 0.8 mm. According to Moulton, similar to female except lighter in color and ocelli lacking. Abdominal sternites II–VII with circular or subcircular glandular areas.

Both Andre and Hood, in 1939, first recognized *mexicanus* by its real characteristics. In their redefinition of the species they showed that D. L. Crawford in describing *mexicanus* and Watson in describing the synonym, *floridensis*, were in error as to the number of epimeral setae. Crawford was further in error on the number and arrangement of head setae present on the holotype of *mexicanus*. Hood (1939b) accounts for the way the original material was misdescribed.

This species is part of the southern biota and is a worldwide tramp. It extends a short distance into Illinois, into the extreme southern counties only. Hood first recorded this species as being in Illinois in 1939.

Illinois records.—ALEXANDER COUNTY: Olive Branch, February 3, 1954, Moore, 1 ♀; McClure, November 20, 1964, McCollum, Johnson grass, 1 ♀. GALLATIN COUNTY: Gibsonia, April 5, 1948, Burks, Stannard, sweeping grass, 1 ♀. PULASKI COUNTY: Mounds, August 26, 1953, Sander-son, Moore, sweeping grass, 1 ♀.

Chirothrips praeocularis Andre

Chirothrips praeocularis Andre (1941: 451). ♀. Type-locality.—Cambridge, Maryland.

Chirothrips bradleyi Hood (1941:142). ♀. Type-locality.—Northfield, New Jersey. New synonymy.

FEMALE (macropterous).—Length distended over 1.6 mm. General color dark brown. Inner base of femora, inner apex of tibiae, and all tarsi yellow. Wings yellow, lightly suffused with brown. Body with orange subintegumental pigment.

Head greatly prolonged in front of eyes, the distance of the vertex between the fore margin of the eyes and the base of the antennae greater than the cheek margin from the base of the eyes to the posterior margin of the head. Vertex with only three pairs of

setae. Ocelli present. Interocellar setae opposite fore ocellus. Antennal segment I not greatly enlarged; segment II drawn out to a sharply pointed apex with its seta placed just below the tip, and with outer margin seemingly ridged or more heavily sclerotized than remainder of segment; segment VI not longer than segments IV and V combined.

Prothorax moderately long; with transverse striae; only moderately setose, setae slender, and with two pairs of prominent posterolateral setae. Prosternum lacking setae. Mesonotum transversely striate. Mesonotum and metanotum without numerous stout setae, with only the normal few pairs. Fore wings well developed.

Abdominal tergites predominantly transversely striate, with few scallop-like markings. Abdominal sternites weakly scalloped except for strong line of scallops just before each posterior margin; posterior margins mostly straight, rarely with toothlike projections. Abdominal segment X pointed, slightly longer than abdominal segment IX.

MALE.—Unknown.

This species and *alexanderae* are unusual in having a thickened ridge along the outer margin of antennal segment II. From *alexanderae*, *praeocularis* may be distinguished by its lack of toothlike projections along the posterior margins of the abdominal sternites and by having antennal segment II more produced at the apex.

Because *praeocularis* is known to occur in Maryland and Louisiana (INHS records) it is possible that populations may also exist in parts of Illinois where the southern biota persists. As yet it has not been found in our state.

Chirothrips spiniceps Hood

Chirothrips spiniceps Hood (1915a:12).

♀. Type-locality.—Glendale-Phoenix region, Arizona. Andre (1939: 198). ♂.

Chirothrips sacchari Moulton (1936b: 181). ♀. Type-locality.—Kailua, Oahu, Hawaii. Synonymized by Hood (1939b).

FEMALE (macropterous).—Length distended more than 1.5 mm. Color generally brown. Yellow to yellow brown: apex of antennal segment II, all tarsi, and joints of fore femora. Fore wings brown except white subbasal band just beyond scale.

Head considerably prolonged beyond eyes, with seven to nine pairs of short, stout setae. Antennal segment I large, segment II greatly produced at outer angle.

Notum of thorax without numerous stout setae. Pronotum with but one pair of epimeral setae. Mesoscutum with scallop-like markings. Mesosternum almost entirely covered by small, stout setae.

Abdominal tergites without an anterior transverse scalloped line. Instead, anterior striae breaking up into light stipple-like areas. Abdominal sternites with weak transverse striae.

MALE (brachypterous).—Length 1.1 mm (Andre 1939). According to Andre, color lighter than in female, yellowish brown with terminal antennal and abdominal segments brown. Similar to female in general structure. Ocelli lacking. Abdominal sternites III–VII each with oval glandular areas.

This species was previously known to occur from California to Florida and northward to Massachusetts. It is recorded here for the first time from Illinois from the sand dune beaches of Lake Michigan.

Illinois record.—LAKE COUNTY: Winthrop Harbor, July 29, 1953, Stannard, on *Panicum virgatum*, 8 ♀.

***Chirothrips texanus* Andre**

Chirothrips texanus Andre (1939:200). ♀, ♂. Type-locality.—Denison, Texas.

Chirothrips auriventris Hood (1939b:469). ♀. Type-locality.—Palacios, Texas. Synonymized by Andre (*in* Bailey 1949a).

FEMALE (macropterous).—Length distended over 1.5 mm. Color predominantly brown, darkest in head and lightest in abdomen, with much yellow to orange or red subintegumental pigment. Apex of antennal seg-

ment II, base of femora, tarsi, and sometimes terminal abdominal segments yellow to yellow brown. Fore wings brown except subbasal regions, this area and hind wings off-white. Ocellar crescents bright red.

Entire body, exclusive of appendages, closely covered with short, stout setae.

Head with about 36 or more pairs of dorsal setae. Antennal segment I large, segment II greatly produced at outer apical angle, style (segments VII and VIII) shorter than segment VI.

Pronotum with many pairs of setae, with two pairs of prominent epimeral setae. Fore legs greatly enlarged (Fig. 79).

Abdominal setae, dorsally and ventrally, less numerous on the terminal segments.

MALE (brachypterous).—Not yet found in Illinois. According to Andre (1939) the male is smaller and paler in color than female. Ocelli absent. Abdominal sternites III–VII with small, circular glandular areas.

This large, spiny species has been collected several times in Illinois and may be statewide in distribution. It is known otherwise only from Texas. The INHS collection includes a series of specimens from Chiapas, Mexico, which are so similar to *texanus* that the two could easily be conspecific or at most be subspecies of each other. Apparently the Haitian *Chirothrips spinosus* Moulton and *C. dorsalis* Hood are the closest relatives of *texanus* at the full species level.

The habits, distribution, and even the variability of the characteristics of *texanus* are in want of further investigation.

Illinois records.—ALEXANDER COUNTY: Roth, July 15, 1954, Ross, Stannard, grass, 1 ♀. COOK COUNTY: West Chicago, August 5, 1949, Evers, Mockford, Stannard, on *Spartina*, 1 ♀. KANE COUNTY: Elgin, September 26, 1956, Ross, Stannard, prairie along railroad, 1 ♀. KENDALL COUNTY: Millington, May 30, 1953, Stannard, on *Andropogon gerardi*, 4 ♀. PULASKI COUNTY: Mounds, August 26, 1953, Sanderson, Moore, sweeping grass, 2 ♀.

Chirothrips vestis Hood

Chirothrips vestis Hood (1915a:15). ♀.

Type-locality.—Vienna, Virginia.

FEMALE (macropterous).—Length distended nearly 1.5 mm. Color yellow and light brown. Head and antennal segments IV–VIII brown. Thorax and legs light brown to yellowish brown. Fore wings clouded with yellowish brown. Ocellar pigment bright red. Body with much orange subintegumental pigment.

Head with about 15 dorsal pairs of short, stout setae. Antennal segment I large, segment II greatly produced at outer apical angle, style (segments VII and VIII) shorter than segment VI.

Thorax with many pairs of short, stout setae. Pronotum with one pair of small epimeral setae (in Kentucky specimens at least). Fore legs greatly enlarged.

Basal abdominal segments with several short, stout, accessory setae. Abdominal segments without strong sculptural designs, without scallops.

MALE.—Unknown.

So far *vestis* has not been discovered in Illinois. It does occur nearby in the Mammoth Cave region of Kentucky, inhabiting *Andropogon*.

This thrips is a smaller, slightly less spiny version of *texanus* Hood or *dorsalis* Hood.

Ctenothrips Franklin

Ctenothrips Franklin (1907:247).

Type-species by monotypy.—*Ctenothrips bridwelli* Franklin.

Head slightly longer than wide, conspicuously bulged half way between the eyes and the base. Ocelli large. Interocellar and postocular setae only moderately developed. Antennae eight segmented, segments III and IV with forked sense cones. Maxillary palps three segmented, labial palps two segmented.

Prothorax weakly striate to almost smooth. Major setae moderately developed with the posterior lateral pairs being the longest. Mesospinasternum not fused to metasternum. Metascutum hexagonally reticulate. All tarsi

two segmented. Fore wings with two veins each completely and regularly set with setae, fringe cilia wavy.

Abdominal tergites and sternites strongly hexagonally reticulate. Abdominal tergites without a pair of closely spaced median setae. Abdominal sternites without accessory setae. Posterior margin of abdominal tergite VIII with a complete comb of setae. Terminal setae of abdominal tergite X long and stout. Abdominal segment X stout, tubelike, completely split on dorsum. Females with well-developed ovipositors. Males with wide, subapical glandular areas, one on each of abdominal sternites III–VIII; without thornlike setae on abdominal tergite IX.

This genus is like *Taeniothrips* except for the tubelike abdominal segment X and the heavy hexagonal reticulations on the abdomen. In *Taeniothrips* abdominal segment X is not tubelike and the abdominal striations are weak. The bulged head of the type species of *Ctenothrips* is similar in appearance to the head of *Taeniothrips orionis*.

In past times four species were placed in this genus: *C. bridwelli* Franklin, *C. frosti* Moulton, *C. floridensis* (Watson), and *C. reticulatus* (D. L. Crawford). Lately the species *reticulatus* has been transferred to *Isochaetothrips* and *floridensis* is considered to be a synonym of *Echinothrips americanus*. Of the remaining two species, only *Ctenothrips bridwelli* occurs in Illinois.

Ctenothrips bridwelli Franklin

Ctenothrips bridwelli Franklin (1907:248). ♀. Type-locality.—Dover, New Hampshire.

FEMALE (macropterous) (Fig. 107).—Length distended about 2.2 mm. Color predominantly blackish brown except thorax, tarsi, and abdominal segment X somewhat lighter. Antennal segments I, II, and VI–VIII dark brown; segments III–V yellow except often segment V brown in apical half. Fore wings white at base, brown in the remaining portion. Posterior setae of abdominal segment IX pale yellow.

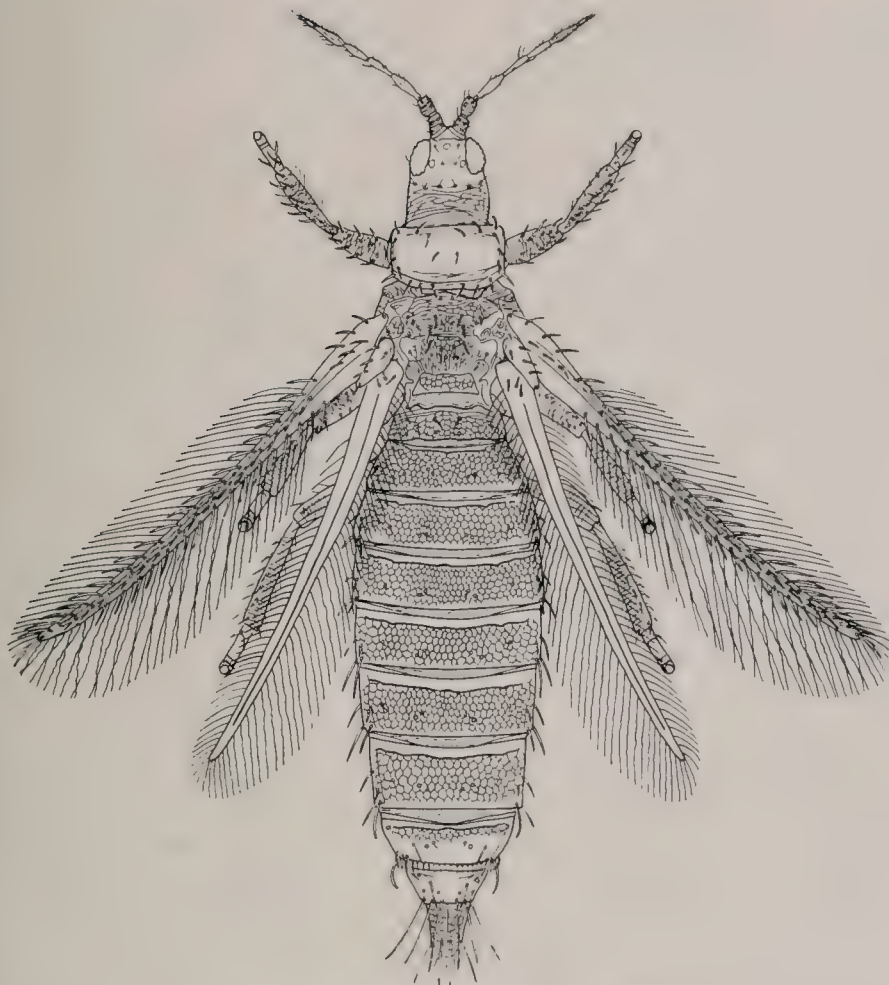


Fig. 107.—*Ctenothrips bridwelli*, dorsal aspect.

Head and prothorax as in Fig. 107. Posterior surface of dorsum of head transversely striate.

Abdomen with setae pointed.

MALE (macropterous).—Length distended about 1.7 mm. Similar to female in general structure and color. Glandular areas diminishing in size from the largest on abdominal sternite III to the smallest on abdominal sternite VIII.

This medium-sized, nearly black species is common throughout Illinois in rich woods. Although it occurs on many plants—such as skunk cabbage, American columbo (*Fraseria*), mayapple, *Smilax*, Solomon's seal, and others—one of its larval hosts appears to be

the green dragon (*Arisaema dracontium*).

In the northern part of Illinois individuals that have antennal segment V mostly brown are often found. Except for this color difference these specimens seem to be conspecific with more typical individuals. Moulton's species *frosti*, based on a single brachypterous female, has the intermediate antennal segments infused with brown similar to some of the material from northern Illinois. It may be that *frosti* is merely a color phase of *bridwelli*.

Illinois records.—Collected from late April to early October, from one to several localities in the following

counties: BOONE, CARROLL, CLARK, COLES, DE WITT, EDGAR, FAYETTE, GREENE, JO DAVIESS, KANE, LAKE, LA SALLE, LAWRENCE, MARION, MARSHALL, MASON, MCHENRY, MCLEAN, OGLE, PEORIA, PIATT, POPE, PULASKI, PUTNAM, RICHLAND, UNION, and VERMILION.

Dendrothrips Uzel

Dendrothrips Uzel (1895:159). Type-species by subsequent designation by Priesner (1925c).—*Dendrothrips ornatus* (Jablonowski) = *Dendrothrips tiliae* Uzel. Valid designation according to the International Code of Zoological Nomenclature, Article 69 (a) (iv) (1961).

Head much wider than long, with anterior margin inset between eyes. Eyes proportionately large. Ocelli widely spaced (Fig. 108). Antennae eight or nine segmented depending upon whether suture between segments VI and VII is incomplete or complete. Antennal segments III and IV seemingly with simple, not forked, sense cones. Maxillary and labial palps two segmented.

Prothorax striate, suggestive of *Scirtothrips* or *Sericothrips*, without major setae. Mesospinasternum fused to metasternum. Metascutum with reticulations tending to become longitudinal striations. Metathoracic furcae enormously enlarged. Tarsi one segmented, hind tarsi not exceptionally elongated. Fore wing slightly downturned at tip, fringe cilia straight.

Abdominal tergites predominantly granulated with hexagonal reticulations on the sides, with a pair of closely spaced setae on the anterior meson of each tergite except for tergites IX and X. Pleural plates present. Tergite VIII with a posterior comb of setae. Tergite X partially split at apex. Ovipositor well developed in female. Males apparently without abdominal sternal glands, and without thornlike setae on abdominal tergite IX.

This genus, composed of more than a dozen named species, is indigenous to the Eastern Hemisphere. It can be recognized by the characteristics of the straight fringe cilia of the fore wing,

the slightly curved appearance of the tip of the fore wing, and the absence of a midtransverse ridge on the prothorax.

Two subgenera, *Monochaetella* and *Dichaetella*, have been included in *Dendrothrips*. Although these categories have been raised to full generic rank by some authors, Priesner, who proposed them, elevated only *Dichaetella* to generic status (Priesner 1949). Another genus, *Dendrothripiella* Bagnall, also resembles *Dendrothrips* and conceivably could be regarded as an additional subgenus. Faure (1960) considered *Dendrothripiella* to be an outright synonym of *Dendrothrips*. Because none of these are present in North America, there is no need to consider them herein.

One species, *Dendrothrips ornatus*, has been introduced in Illinois where on occasions it causes severe damage to privet hedges and lilac bushes.

***Dendrothrips ornatus* (Jablonowski) Privet Thrips**

Thrips ornata Jablonowski (1894:94). ♀, ♂. Type-locality.—Hungary. Placed in *Dendrothrips* by Bagnall (1914).

Dendrothrips tiliae Uzel (1895:160). ♀, ♂. Type-locality.—Czechoslovakia. Synonymized by Bagnall (1914).

FEMALE (macropterous).—Length distended about 1.2 mm. Bicolored brown and yellow. Brown: head except sometimes lighter in the middle; antennal segments I, II, and VI–IX; spots on prothorax; most of pterothorax; legs except tarsi and tips of hind tibiae; most of the base, two separated bands, and tips of fore wings; and most of the abdomen except the median parts of abdominal tergites II–VIII and lighter lateral spots on these same tergites. Rest of body yellow to nearly colorless. Red to orange subintegumental pigment distributed throughout the body and underlying the ocelli.

Head as in Fig. 108. Interocellar setae minute, postocular setae seemingly absent.

Prothoracic setae minute. Fore wings with each fore vein regularly set

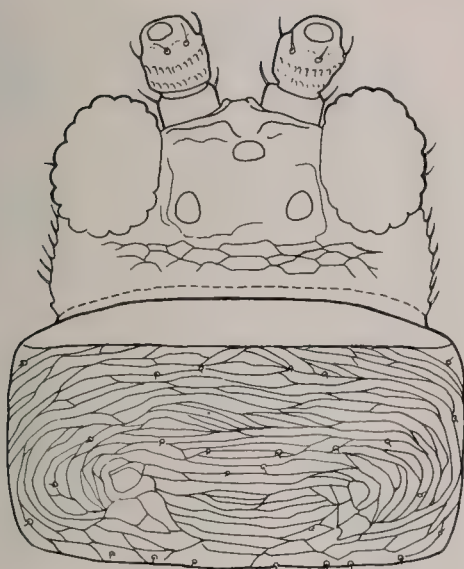


Fig. 108.—*Dendrothrips ornatus*, head and prothorax.

with closely spaced setae, hind veins with only a few setae.

Abdominal tergite VIII with posterior comb composed of minute setae at the sides and with larger setae at the middle.

MALE (macropterous).—Length distended about 0.7 mm. Similar to female in color and structure except generally lighter.

It is unfortunate that this pretty thrips is an economic pest; otherwise, *ornatus* could be looked upon favorably as a handsome addition to our fauna.

The privet thrips, as its common name implies, lives on privet and often on lilac and can cause damage to both hosts. It is common in the northern half of Illinois. So far it has not spread into the South or into the West. Introduced from Europe, it was first recorded in the United States from New Jersey in 1931 by the late Mr. Moulton. In 1936 it was reported from Ames, Iowa, by Moulton and Andre.

Dr. W. S. Brooks, who collected many of these thrips in Illinois in 1962, found that the adults occurred mostly on the upper side of the leaves.

Illinois records.—Collected from June to mid-October, from one to sev-

eral localities in the following counties: ADAMS, CARROLL, CHAMPAIGN, CHRISTIAN, CLARK, COOK, CRAWFORD, EDGAR, FAYETTE, FULTON, HENRY, JASPER, JO DAVIESS, KANKAKEE, LA SALLE, LAWRENCE, MC-HENRY, MCLEAN, MARSHALL, MASON, MOULTRIE, OGLE, PEORIA, PIATT, PIKE, RANDOLPH, RICHLAND, SHELBY, STEPHENSON, TAZEVELL, WINNEBAGO, and WOODWARD.

Dorcadothrips Priesner

Dorcadothrips Priesner (1932:49).

Type-species by original designation.—*Dorcadothrips caespitis* Priesner.

Head wider than long, eyes strongly protruding, cheeks constricted behind eyes. Antennae eight segmented, segments VI–VIII elongate, segments III and IV with forked sense cones varying from U-shaped to Y-shaped. Mouth cone broadly rounded. Maxillary palps three segmented in the American species, described as being two segmented in the Egyptian type-species.

Prothorax with only the two pairs of epimeral setae well developed. Metafurcae not enlarged. Fore legs not enlarged. Macropterous, brachypterous, or apterous. All tarsi two segmented. Fore wings, when developed, narrow, with two veins; setae on fore veins broadly interrupted, setae on hind veins uniformly spaced; fringe cilia wavy.

Abdominal tergites without microsetae. Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal sternites with accessory setae in addition to the posterior ones. Abdominal tergite VIII lacking posterior comb of setae. Abdominal tergite IX lacking pore areas. Female with abdominal tergite X entire, not split dorsally. Male with abdominal sternites III–VII each with a transverse, elliptical glandular area, abdominal tergite IX with a pair of sinuate dorsal processes (see Priesner 1932, page 50, Fig. 2).

Except for the lack of pores on abdominal tergite IX and for the slender, curved, linear processes arising from

the posterior border of tergite IX in the male, *Dorcadothrips* closely resembles *Taeniothrips*.

So far only one species, *walteri*, is known from North America. It has been taken in southern Illinois, Michigan, and New York.

***Dorcadothrips walteri* Crawford, J. C.,**
new generic assignment

Taeniothrips walteri Crawford, J. C.
(June, 1941b:142). ♀. Type-locality.—Kalamazoo, Michigan.

Dorcadothrips nevini Hood (July, 1941:145). ♀, ♂. Type-locality.—Ringwood, Tompkins County, New York. New synonymy.

FEMALE (macropterous).—Length distended about 1.5 mm. Color predominantly yellow with some gray-brown. Gray-brown: antennal segment II; apical half of antennal segments III, IV, most of V, and all of VI–VIII; dorso-lateral anterior portions of abdominal segments II–VI. Fore wings with a narrow subbasal brown crossband. Ocellar pigment orange-red.

Head slightly elongate, just barely bulged behind eyes. Interocellar setae long. Antennal segments elongate, segment VI exceptionally long and slender.

Prothorax with a few dorsal setae, with two pairs of posterior setae between the major epimeral setae. Fore tarsi without claws. Fore wings with one distal seta on fore vein.

Abdominal sternites III–VII with accessory setae in addition to the posterior ones. Abdominal tergite VIII without complete posterior comb of setae.

MALE (apterous).—Length 1 mm. Color and structure as in female. Abdominal sternites III–VII each with transverse, elliptical median glandular area, and tergite IX with a pair of curved posterior processes.

Dorcadothrips walteri is a grass inhabitant. It is rare in collections.

Illinois record.—JACKSON COUNTY: Gorham (Fountain Bluff), August 16, 1950, Stannard, *Andropogon* on hill prairie, 1 ♀.

Drepanothrips Uzel

Drepanothrips Uzel (1895:213). Type-species by monotypy.—*Drepanothrips reuteri* Uzel.

Head wider than long. Antennae six segmented, segments III and IV each with a forked sense cone, segment VI the longest. Head setae much as in *Sericothrips*. Maxillary palps three segmented.

Prothorax transversely striate, with several bare areas typical of those species belonging to the *Sericothripini*; with no setae strongly developed except several setae on the posterior margin slightly longer than the others. Mesospinasternum separated from metasternum by a suture. All tarsi two segmented. Fore wings with setae on both veins interrupted, fringe cilia wavy.

Abdominal tergites with median setae not as close together as in *Sericothrips*. Abdominal sternites without accessory setae. Sides of abdomen with numerous microsetae. Abdominal tergite VIII with a complete comb of setae along posterior margin. Female with well-developed ovipositor. Males with a pair of greatly enlarged setae arising from abdominal segment X.

This genus is easily distinguished from those others that possess many microsetae on the abdomen by the characteristic of the six-segmented antennae.

Drepanothrips is a monobasic genus containing only the type-species which is reported herein for the first time as an established species in Illinois.

***Drepanothrips reuteri* Uzel** Grape Thrips

Drepanothrips reuteri Uzel (1895:213). ♀, ♂. Type-locality.—Czechoslovakia.

Thrips betulicola Reuter, O. M. (1899:59). ? ♀. Type-locality.—Pargas (Parainen), Turku-Pori, Finland. Synonymized by Priesner (1930).

Drepanothrips viticola Mokrzecki (1901:?). ♀. Type-locality.—? Ukraina (U.S.S.R.). Synonymized by Fulmek and Karny (1915).

FEMALE (macropterous).—Length distended about 0.9 mm. General color light yellow. Antennal segment I nearly colorless, segments II–VI each becoming progressively more brown than the preceding segments. Thorax with brown spots. Abdominal segments II–VII each with a brown basal band connected to brown patches at sides. Ocelli red. Fore wings uniformly grayish brown.

Head with mouth cone moderately long and somewhat pointed.

Mesosternum and metasternum with a median longitudinal ridge.

Abdominal sternites II–VII with major setae on the posterior margin of each segment.

MALE (macropterous).—Length distended about nearly 0.8 mm. Color and structure much as in female except lighter and without brown spots on the thorax and abdomen. Terminal, enlarged, sickle-shaped setae black except yellow at extreme base.

Abdominal sternites seemingly without glandular areas. Abdominal tergite IX without thornlike setae.

This European species, known to have been introduced to North America as early as 1926 (Moulton 1926*a*), has now been found in Illinois, in Urbana. It is reported in the literature to be a pest of grapes.

Bailey (1942) gave an account of the biology of this thrips and listed the important literature concerning it.

Illinois record.—CHAMPAIGN COUNTY: Urbana, July 25, 1947, Ross, from sparrow nest built in grape arbor, 2 ♀.

Echinothrips Moulton

Echinothrips Moulton (1911:37). Type-species by monotypy.—*Echinothrips mexicanus* Moulton.

Head about as long as wide, reticulate to transversely striate, in profile slightly constricted at side. Eyes large. Ocelli present on slightly raised area between eyes. Antennae eight segmented, antennal segment III constricted subbasally (Fig. 67), segment VI and style elongated and nonpedicellate. Sense cones on antennal segments III and IV single, not forked.

Maxillary palps seemingly two segmented, labial palps two segmented.

Prothorax reticulate, with or without wrinkle-like sculpture within the reticules; posterior angles each with two well-developed setae. Mesospinasternum fused to metasternum. Metascutum hexagonally reticulate. Fore femora each with an enlarged clublike seta at base on dorsum. Tarsi two segmented. Always macropterous. Fore wings with two rows of heavy, stout spines; many fringe cilia wavy.

Abdominal tergites with or without microsetae on sides, with a median pair of closely spaced setae on most tergites. Pleural plates fused to dorsum. Comb on abdominal tergite XIII complete. Abdominal tergite X not split. Abdominal sternites without accessory setae. Ovipositor well developed in female. Males with abdominal sternal glands, without thornlike setae on abdominal tergite IX.

This genus can be recognized in Illinois by the combination of the clublike setae at the base of the fore femora, the heavy fore wing setae, and the hexagonally reticulate pronotum which bears two pairs of well-developed posteroangular setae.

Of the two described species that occur in the United States only one, *Echinothrips americanus*, is native to Illinois. It is likely that the other species, *subflavus*, may be introduced, from time to time, into our state on imported hemlock trees. Additional species inhabit Central and South America and the West Indies.

KEY TO SPECIES
(OF NORTH AMERICA)

- 1. Abdominal tergites without microsetae; from Mexico and Honduras. **mexicanus**
Abdominal tergites with microsetae at the sides of segments II–VII. 2
- 2. Pronotal reticules with wrinkle-like sculpture. 3
Pronotal reticules without conspicuous wrinkle-like sculpture. 4
- 3. Fore wings dark brown just beyond scale, lighter in the middle; eastern North America on forest herbs. . . **americanus**
Fore wings, beyond scale, uniformly dark brown; southern Florida. . . **floridensis**
- 4. Body generally dark brown; major setae of wings dilated at tip; from the West Indies to Panama and Trinidad. **caribeanus**

Body generally yellow; major setae of wings pointed to nearly blunt; from eastern North America on hemlock. . . .
subflavus

Echinothrips americanus Morgan

Echinothrips americanus Morgan (1913:14). ♀, ♂. Type-locality.—Quincy, Florida.

FEMALE (macropterous).—Length distended about 1.6 mm. General body color dark brown with much red subintegumental pigment. Antennal segments I and II dark brown concolorous with head; segments III, IV and basal half of V light yellowish gray; remainder of antennae light brown. Base of femora, apex of tibia, and all of tarsi yellow. Fore wings pale gray at base, middle, and tip, and light brown in between these paler bands.

Head with wrinkles inside reticulations. Interocellar setae and postocular setae moderate in size. Antennae as in Fig. 67.

Prothorax with wrinkles inside reticulations. Major prothoracic setae blunt at tips. Wings with major bristles blunt to dilated at tips.

Abdominal tergites II–VII with microsetae on sides.

MALE (macropterous).—Length distended nearly 1.3 mm. Color and general structure as in female. Abdominal sternites III–VIII each with many closely scattered, small, oval or circular glandular areas (Fig. 47). Abdominal terminalia as in Fig. 44.

This common species has a range which extends from southern Quebec (INHS) to Florida, westward to at least central Iowa. It occurs mostly outside the Wisconsin drift area in Illinois (Fig. 23) on many forest plants and in particular on jewelweed, (*Impatiens*).

The other known species from eastern United States, *Echinothrips subflavus*, is host specific to hemlock, a tree that does not occur naturally in Illinois. Although hemlock is planted as an ornamental, its thrips does not seem to have become established here as yet. Among other characteristics, *subflavus* differs from *americanus* in being predominantly yellow and in

having the wing bristles pointed instead of blunt or dilated at the tips.

The species *floridensis*, described by Watson (1919), was synonymized by Hood (1927b) with *americanus*. In my opinion *floridensis* is a separate species distinguished by having dark-colored wings. I have studied the type from Miami and a specimen I collected from the Everglades.

Illinois records (Fig. 23).—Collected from June to October, from one to several localities in the following counties: ADAMS, ALEXANDER, CLARK, COLES, CRAWFORD, EFFINGHAM, FULTON, HAMILTON, HARDIN, HENDERSON, HENRY, JACKSON, JERSEY, JOHNSON, LAWRENCE, MACON, MACOUPIN, MONROE, OGLE, PIATT, PIKE, POPE, PUTNAM, SCHUYLER, SHELBY, SCOTT, and WABASH.

Echinothrips subflavus Hood

Echinothrips subflavus Hood (1927c: 213). ♀. Type-locality.—Little Valley, New York.

FEMALE (macropterous).—Length distended about 1.6 mm. General color yellow. Antennal segments I and II, base of III, apexes of IV and V, apical two-thirds of VI, and all of VII and VIII brown, with segment II the darkest. Northern specimens (Canada and New York) often with light brown shading at base of head, within prothorax, and on abdominal sternites II–VI; southern specimens (Kentucky and Tennessee) yellow except for brown on the antennae. Wings light yellow. All setae yellow. Ocellar pigmented red.

Head (Fig. 109) with transverse reticulations which are without wrinkles. Interocellar and postocular setae moderate in size.

Prothorax reticulate with only very faint, degenerate traces of wrinkle-like sculpture inside the reticules. Major setae pointed to blunt at tip. Fore wing with major setae pointed to blunt at tip.

Abdominal tergites II–VII with microsetae on sides.

MALE (macropterous).—Length distended about 1.3 mm. Similar to fe-

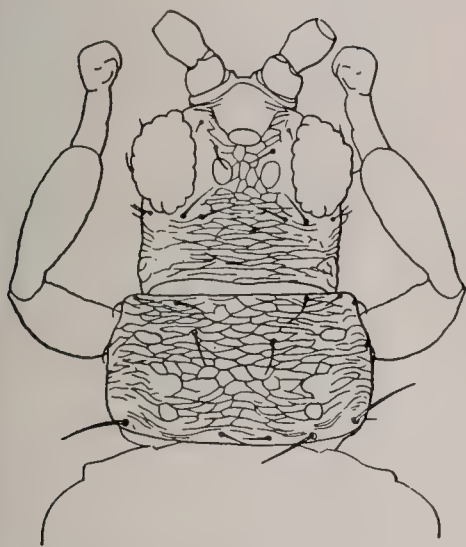


Fig. 109.—*Echinothrips subflavus*, head and prothorax. From Hood (1927c).

male in color and structure. Abdominal sternites III–VIII each with many closely scattered, small, oval or round glandular areas.

This species is the only one in the genus which is yellow rather than dark brown in color. It occurs on hemlock needles from Quebec to the Great Smoky Mountains in Tennessee. As yet it has not been found in the Midwest. Repeated attempts have been made to collect specimens from relict stands of hemlock in Indiana with no success.

Although hemlock is not native to Illinois, it is a tree which is often brought in and planted in our state as an ornamental. Possibly *subflavus* might come into Illinois in the future on nursery stock. Within its natural range, this species has not been reported to be of economic importance.

Frankliniella Karny

Frankliniella Karny (1910:46, footnote). Type-species by subsequent designation by Hood (1914a).

Thrips intonsa Trybom = *Physopus vulgatissima* sensu Uzel nec Haliday. (See explanation in discussion following.)

Head wider than long to slightly

longer than wide. Ocelli generally placed farther apart than in the species of *Thrips*, sometimes reduced or absent in brachypterous forms. Inter-ocellar and postocular setae often well developed. Antennae eight segmented, antennal segments III and IV each with a forked sense cone. Mouth cone moderate in size, pointed to rounded at tip. Maxillary palps three segmented.

Prothorax in the Illinois species with major, well-developed setae on both the anterior and posterior angles. Mesospinasternum separated by a suture from the metasternum. Macrop-terous or brachypterous. Fore wings, when fully developed, with two veins both of which are regularly and uniformly set with setae; fringe cilia wavy. Tarsi two segmented.

Abdominal sternites without accessory setae. Median pair of sternal setae placed on the posterior margin of the sternites. Median pair of tergal setae placed far apart on the intermediate tergites. Abdominal tergite VIII with or without a complete comb of setae on posterior margin. Female with well-developed ovipositor, abdominal tergite X split. Males with a glandular area on each of sternites III–VII, abdominal tergite IX with shortened setae which may or may not be thornlike. Males often yellow.

The designation of the type-species of *Frankliniella* was validly made by Hood (1914a) according to the International Code of Zoological Nomenclature (1961). Because this designation is so involved an explanation seems worthwhile.

Originally Karny proposed *Frankliniella* without reference to any species that should be included in it. A year later Bagnall (1911b) listed seven species in *Frankliniella* and, according to the International Code of Zoological Nomenclature, Article 69 (a) (ii) (1961), these are the only species from which a type-species may be selected. One of the listed species was *vulgatissima* Haliday, which in Bagnall's time was the name for a species used in the sense of Uzel and not Haliday as pointed out by Karny (1912b). Later, in 1914, Hood designated the type-

species of *Frankliniella* as "*Thrips intonsa* Trybom = *Physopus vulgarissima*, Uzel, nec Haliday." Such designation is in accordance with Article 69 (a) (iv) of the Code (1961), which provides for the selection of a type-species when synonymizing that species with one of the first included species, and in accordance with Article 70 (b) of the Code, which provides that in the case of a name based on the wrong usage of a previous author, the type-species is to be interpreted as the one actually before the designator.

Frankliniella as a category grades into *Taeniothrips* as *Taeniothrips* grades into *Thrips*. No unique characteristics can be found to differentiate each of these genera when all of the described species are considered. Locally, in Illinois, the three genera can be readily distinguished because the intermediate species are not present here.

In Illinois all species that belong to *Frankliniella* have eight segments in each antenna, the anterolateral pair of major prothoracic setae are long, the midlateral prothoracic setae are short and the fore wings when present always have the two longitudinal veins evenly set with setae.

Seven species occur in our state. Of these, *tritici* causes considerable trouble to commercial rose growers by blasting parts of rose buds, and *tenuicornis* and *fusca* probably cause minor damage to field crops.

KEY TO SPECIES

1. Macropterous 2
Brachypterous 14
2. Pedicel of antennal segment III with a distinctly thickened middle ring which in profile appears as angulations *tritici*
Pedicel of antennal segment III straight or nearly straight along sides 3
3. Head distinctly prolonged in front of eyes 4
Head flattened in front, not prolonged forward of eyes 5
4. Abdominal tergites almost entirely dark brown or at least clouded with brownish gray patches *tenuicornis*
Abdominal tergites yellow *unicolor*
5. Females 6
Males 10
6. Abdomen yellow 7
Abdomen predominantly brown 8
7. Anteromarginal prothoracic setae shorter

- than or nearly equal to dorsal length of eye *runneri*
Anteromarginal prothoracic setae much longer than dorsal length of eye; not yet found in Illinois *williamsi*
8. Postocular setae stout, as stout as the interocellar pair *stylosa*
Postocular setae more slender than the interocellar pair 9
 9. Antennal segments III and IV predominantly brown (in part) *fusca*
Antennal segments III and IV largely yellow; not yet found in Illinois *hemerocallis*
 10. Setal comb on posterior margin of abdominal tergite VIII complete 11
Setal comb on posterior margin of abdominal tergite VIII interrupted 12
 11. Anteromarginal prothoracic setae shorter than or nearly equal to dorsal length of eye *runneri*
Anteromarginal prothoracic setae much longer than dorsal length of eye; not yet found in Illinois *williamsi*
 12. Predominantly brown; not yet found in Illinois *hemerocallis*
Predominantly yellow 13
 13. Postocular setae stout, as stout as the interocellar pair *stylosa*
Postocular setae much more slender than the interocellar pair (in part) *fusca*
 14. Postocular setae small and much more slender than the interocellar pair (in part) *fusca*
Postocular setae larger, as stout as the interocellar setae *andrei*

Frankliniella andrei Moulton

Frankliniella andrei Moulton (1936a: 63). ♀. Type-locality.—not definitely stated but either Waterville, Ottumwa, or McGregor, Iowa.

FEMALE (brachypterous).—No specimens available to me. According to Moulton (1936), generally dark brown except tips of tibiae and all tarsi which are yellowish brown. Postocular setae much longer than in *fusca*. Abdominal tergite VIII with an irregular comb of setae along posterior margin.

MALE (brachypterous).—Length distended about 1 mm. Generally dark brown in color except abdominal segments IX and X which are abruptly yellowish brown. Tips of tibiae and all of tarsi light brown to yellowish brown. Ocellar pigments red. Thorax with orange subintegumental pigment.

Head moderate in size, not prolonged forward in front of eyes. Postocular setae moderately long, as stout as interocellar setae. Ocelli fully de-

veloped. Antennal segment III with sides of pedicel straight.

Prothorax with major setae moderately long.

Abdominal tergites II–VIII with median pair of setae as well developed as lateral setae. Glandular areas elliptical, moderate in size, proportionately smaller than in *fusca* or *hemerocallis*, one each on sternites III–VII. Abdominal tergite VIII with an irregular but nearly complete comb of setae on posterior margin. Abdominal tergite IX with median setae shortened but not thornlike; lateral setae long.

This rare species is like *fusca* in the dark coloration of antennae and body. It differs from *fusca* most conspicuously by the larger postocular setae and by the darker coloration of the male.

So far *andrei* has only been taken from moss, which may be its principal host.

Illinois record.—LA SALLE COUNTY: Starved Rock State Park, July 18, 1953, Rhode, from moss, 1 ♂.

***Frankliniella fusca* (Hinds)**
Tobacco Thrips

Euthrips fuscus Hinds (1902:154). ♀.

Type-locality.—Massachusetts.

Morgan (1913:11). ♂. Transferred

to *Frankliniella* by Karny (1912b).

Euthrips nicotianae Hinds (1905:198).

♀. Type-locality.—Quincy, Florida.

Synonymized by Hood (1914a).

Scirtothrips owreyi Watson (1924b:51).

♀. Type-locality.—Jacksonville,

Florida. Synonymized by Hood

(1927b).

FEMALE (macropterous).—Length distended about 1.3 mm. Color generally dark brown (overwintering specimens) to lighter brown especially in the thorax and head (some summer specimens). Antennae concolorous with body, although basal segments sometimes slightly lighter. Legs, especially apical half of tibiae and all tarsi, lighter than body, fading to yellowish brown or yellow. Fore wings light grayish brown. Ocellar pigment red. Thorax and abdomen with orange subintegumental pigment.

Head moderate in size, not prolonged forward in front of eyes. Inter-

ocular setae moderately long, postocular setae small and more slender than the interocular setae. Antennal segment III with sides of pedicel straight.

Prothorax with major setae moderately long, inner anterior pair of major setae smaller than or nearly equal to dorsal length of eye. Metascutum with the median striations transverse.

Abdominal tergite VIII with comb of setae along posterior margin interrupted.

FEMALE (brachypterous).—Size about same as macropterous form but occasionally slightly smaller. Color as in fully winged female except thorax sometimes yellow to light yellowish brown.

Ocelli reduced in size. Wings reduced to pads.

Abdominal tergites with the median setae usually small as in the macropterous form but occasionally with these setae as strongly developed as the lateral setae. In the specimens which have these median setae developed, the ocelli are usually absent.

MALE (macropterous).—Length distended about 1.2 mm. Color generally yellow, clouded with light brown patches on thorax and abdominal segments I and II. Antennae often with areas of yellowish brown in basal segments.

Similar to macropterous female in structure. Abdominal glandular areas elongately transverse ellipses, one each on sternites III–VII. Abdominal tergite IX with median setae reduced but not thornlike, lateral setae long.

MALE (brachypterous).—Length distended about 1 mm. Structure and usually color similar to structure and color of macropterous male, except wings reduced to pads and ocelli reduced. Rarely darker in color, with head, antennae, thorax, legs, and abdominal segments I–IV brown (only one such dark male known to me).

This species is variable in structure in that it has a macropterous and a brachypterous form in both sexes with corresponding changes in the size of the ocelli and sometimes in the size of the median setae of the abdominal tergites, and it is variable in color in that it has a darker overwintering color as

contrasted to the lighter summer color. It differs from the closely related *hemerocallis* in that antennal segments III and IV are not abruptly yellow, and from *andrei* by the smaller size of the postocular setae and the complete absence of comb setae on the median part of the posterior margin of abdominal tergite VIII.

Frankliniella fusca is one of our most common thrips, occurring over the entire state in great numbers (Fig. 110). Usually it inhabits grasslands where it feeds on herbs. We have found this species feeding on the inside of sheaths of *Tradescantia* and sheaths of gladioli. In addition it has been taken from flowers and even from tree leaves. The brachypterous forms, at least, can leap for a distance of an inch or more.

According to Hinds (1905), Morgan (1913), and others, *fusca* damages to-

bacco, and Poos (1941) and Dogger (1956) reported that it causes damage to peanuts. In Illinois this species has not yet been reported to be a significant pest.

Illinois records (Fig. 110).—Collected every season of the year, from one to several localities in the following counties: ALEXANDER, BOND, CARROLL, CHAMPAIGN, CLINTON, COOK, DEWITT, EFFINGHAM, FAYETTE, FORD, FRANKLIN, FULTON, GALLATIN, GREENE, HANCOCK, HARDIN, HENDERSON, IROQUOIS, JACKSON, JOHNSON, KANE, KANKAKEE, LA SALLE, LEE, LOGAN, MACOUPIN, MARION, MASON, MASSAC, MCLEAN, MERCER, OGLE, PEORIA, PIATT, PIKE, POPE, RANDOLPH, SANGAMON, SCOTT, UNION, VERMILION, WHITESIDE, WILL, WINNEBAGO, and WOODFORD.

Frankliniella runneri (Morgan)

Euthrips runneri Morgan (1913:7). ♀.

Type-locality.—Clarksville, Tennessee. Transferred to *Frankliniella* by Hood (1914a).

Frankliniella gilmorei Morgan (1925b:140). ♀. Type-locality.—Clarksville, Tennessee. New synonymy.

FEMALE (macropterous).—Length distended about 1.3 mm. General color yellow. Antennal segment I light yellow, segment II brown, segment III largely yellow but with tip of apex light brown, segments IV and V yellow in basal half and brown in apical half, segment VI mostly brown but base often yellowish brown, segments VII and VIII brown. Major body and wing setae brown. Ocellar pigment orange to red.

Head moderate in size, not prolonged forward of eye margin, with postocular setae much smaller than interocellar setae. Antennal segment III with sides of pedicel nearly straight.

Prothorax with major anterior setae smaller than major posterior pairs; inner pair of the major anterior setae shorter than or nearly equal to the dorsal length of the eye.

Abdominal tergite VIII with a complete comb of fairly long, light-colored setae along the posterior margin.

MALE (macropterous).—Length

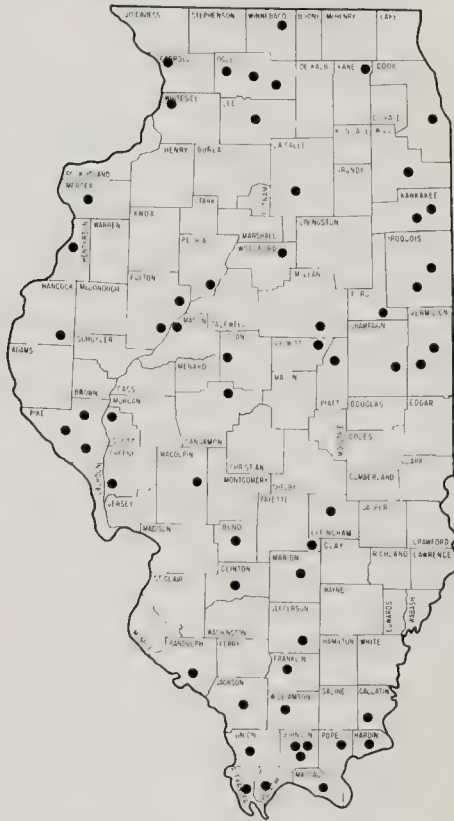


Fig. 110.—Distribution of *Frankliniella fusca* in Illinois.

distended about 0.9 mm. Similar to female except smaller and somewhat lighter in color. Abdominal glandular areas moderate in size, elliptical, one each on sternites III–VII. Abdominal tergite VIII with a complete comb of setae along posterior margin, as in female. Abdominal tergite IX with median pair of setae shortened and slightly thornlike but smaller in size than as in *williamsi*, lateral setae fairly long.

For the moment, at least, those Illinois specimens assigned here have been named *runneri*. It is possible that *gilmorei* is distinct, being host specific to *Monarda*, but until morphological or other characteristics can be found to separate *gilmorei* from *runneri*, I prefer to regard them as the same entity. According to Moulton (1948), *F. gilmorei* and *F. exigua* are names for the same species. If so, *exigua* could also be a synonym of *runneri*.

Close relatives of *runneri* occur in the South. The species *gossypiana* Hood is reported to be similar in appearance, and *williamsi* resembles *runneri* in many features. The southwestern species, *gossypiana*, is unknown to me. *Frankliniella williamsi*, a common pest of corn in Central America and other tropical regions, differs from *runneri* conspicuously by the longer third antennal segment, by its slightly larger size, and by the longer body setae.

Our specimens of *runneri* vary from light to dark yellow in color. They can be distinguished from the other Illinois species of the genus of the same color by the long, uninterrupted, comb of setae on the posterior margin of abdominal tergite VIII as exhibited by both sexes, by the absence of abrupt thickenings on the pedicel of antennal segment III, and by the flattened rather than protruding fore margin of the head.

This thrips has been found throughout the state on native as well as on cultivated plants. It is one of the thrips which attack and damage cotton (Anonymous 1962). It extends northward at least as far as southern Michigan (INHS records).

Illinois records.—Collected from June to early November, from one to

several localities in the following counties: CHAMPAIGN, JACKSON, JASPER, KANE, LOGAN, MASON, MCLEAN, OGLE, PIATT, PIKE, and RICHLAND.

***Frankliniella stylosa* Hood**

Frankliniella stylosa Hood (1912c:134).

♀. Type-locality.—Plummer's Island, Maryland. Moulton (1948: 98). ♂.

Euthrips floridensis Morgan (1913:5).

♀. Type-locality.—Quincy, Florida. Synonymized by Hood (1917).

FEMALE (macropterous).—Length distended about 1.6 mm. Bicolored dark brown and light brown to yellow. Head, thorax and legs light brown to yellow, with the head and legs lightest; abdomen dark brown. Antennal segment I light brown, segment II dark brown, segments III–V brown at apex and yellow at base, segments VI–VIII brown. Fore wings grayish brown. Ocellar pigment orange to red. Body setae dark brown.

Head moderate in size, not prolonged forward of eye margin, with postocular and interocellar setae equally stout. Antennae as in Fig. 69, segment III with sides of pedicel nearly straight.

Prothorax with major setae long, all except the midposterior pair nearly equal in length and much longer than the dorsal length of the eye. Metascutum longitudinally striate.

Abdominal tergite VIII with a complete comb of setae on posterior margin, these setae small and fairly widely spaced.

MALE (macropterous).—Length distended about 1.2 mm. Color yellow. Antennae colored much as in female except lighter. Body setae brown. Abdominal glandular areas moderate in size, elliptical, one each on sternites III–VII. Abdominal tergite VIII with comb of setae interrupted. Abdominal tergite IX with median pair of setae shortened but not thornlike, lateral setae longer.

This species is easily distinguished by the characteristics given in the key. During spring and summer it is found in many woodland flowers throughout our state.

Illinois records.—Collected from April through September, from one to several localities in the following counties: CALHOUN, FULTON, GREENE, JEFFERSON, JO DAVIESS, LA SALLE, LEE, MONROE, POPE, UNION, and WINNEBAGO.

***Frankliniella tenuicornis* (Uzel)**

Physopus tenuicornis Uzel (1895:99). ♀, ♂. Type-locality.—Czechoslovakia. Transferred to *Frankliniella* by Bagnall (1911b).

Physopus nervosa Uzel (1895:102). ♀. Type-locality.—Czechoslovakia. Synonymized by Priesner (1926b).

Thrips (Euthrips) maidis Beach (1896:219). ♀. Type-locality.—Ames, Iowa. Synonymized under *nervosus* by Hinds (1902).

FEMALE (macropterous).—Length distended about 1.6 mm. Color generally dark brown. Antennal segments III and IV, tips of femora, all tibiae, and all tarsi yellow to yellowish brown. Wings light yellow. Ocellar pigment red. Pterothorax with orange subintegumental pigment.

Head not as long proportionately as in *unicolor*, prolonged forward in front of eyes. Interocellar setae long, postocular setae short. Antennal segment III with sides of pedicel straight.

Prothorax with most of the major setae long; inner pair of the major anterior setae shorter than or nearly equal to the dorsal length of the eye. Metascutum longitudinally striate.

Abdominal tergite VIII with comb of setae along posterior margin reduced to scallops or basal scales.

MALE.—Not as yet found in Illinois, no specimen available to me. According to Priesner (1926b) the male is smaller than the female and is generally yellow with the abdominal tergites clouded by brownish gray color.

This is the only species of *Frankliniella* in Illinois which has a prolonged head and is brown or with brownish abdominal coloration.

Seemingly *tenuicornis* is the Old World equivalent of *unicolor*. Evidently it was introduced into the Midwest many years ago, at least prior to 1896 when Miss Beach described it under

the name *maidis*. In Illinois it probably reproduces parthenogenetically.

Frankliniella tenuicornis is statewide in distribution and is often found under the sheaths of corn in great numbers. In Europe I have collected it under the sheaths of cattails. The extent of its damage to corn or other grasses has not been determined in Illinois.

Illinois records.—Collected every month of the year, from one to several localities in the following counties: ADAMS, BOND, CALHOUN, CHAMPAIGN, CLINTON, CRAWFORD, COOK, CUMBERLAND, DE WITT, DOUGLAS, EDGAR, FULTON, HANCOCK, IROQUOIS, JOHNSON, KANE, KANKAKEE, KNOX, LAKE, LOGAN, MACON, MARION, MASON, MCLEAN, MORGAN, OGLE, PIATT, PIKE, ROCK ISLAND, SALINE, SCOTT, STARK, TAZEWELL, VERMILION, WABASH, and WILL.

***Frankliniella tritici* (Fitch)**

Eastern Flower Thrips

Thrips tritici Fitch (1855a:385). ? ♀. Type-locality.—Geneva, Wisconsin. Osborn (1883:156). ♂. Transferred to *Frankliniella* by Karny (1912b).

Frankliniella varicorne Bagnall (1919:368). ♀, ♂. Type-locality.—Semenans, Saskatchewan. Synonymized as a form of *tritici* by Blickenstaff (1946).

Frankliniella tritici f. *maculata* Priesner (1925b:17). ♀. Type-locality.—Canada. A varietal name for the intermediate color phase?

Frankliniella fulvus Moulton (1936a:61). ♀, ♂. Type-locality.—Fargo, North Dakota. Synonymized under *Frankliniella tritici* f. *varicorne* (misspelled *varicornis*) by Moulton (1948).

FEMALE (macropterous) (Fig. 38).—Length distended about 1.5 mm. Color generally yellow to dark brown. Head pale brown to dark brown. Thorax light yellow but with much orange subintegumental pigment. Abdomen either pale yellow with brown patches on the meson or entirely dark brown. Antennal segment I pale yellow, segment II dark brown, segment III brownish yellow except pale at base,

segment IV brown except pale at base, segment V yellow except brown at apex, segments VI–VIII dark brown. Ocellar pigment red.

Head flat anteriorly, not protruding in front of eyes. Pedicel of antennal segment III with sharp angulations in profile.

Posterior setal comb on abdominal tergite VIII incomplete.

MALE (macropterous).—Length distended about 1.2 mm. General color pale yellow, antennae colored as in female but sometimes lighter. Similar to female in general structure. Abdominal sternites III–VII each with a transverse elliptical glandular area, these areas pale and often difficult to see. Abdominal tergite IX with median setae shortened but not thornlike, lateral setae moderately long.

Frankliniella tritici is the common eastern flower thrips. Its biological equivalent is the western flower thrips, *F. occidentalis*, which is naturally found west of the Rocky Mountains, rarely by accidental importation in greenhouses in eastern states. Both cause considerable and similar damage to many kinds of flowers and newly formed small fruits. The species *tritici* may be distinguished from others in Illinois by the angular thickenings on the pedicel of antennal segment III.

In the Midwest *tritici* has two color phases, dark and light, with all degrees of coloration in between. The light phase is statewide in distribution in Illinois whereas dark specimens occur mostly in the northern counties. The darker phase, formerly called *varicorne*, does not appear in populations to the south or east of Illinois and Indiana; rather such specimens are found to the north in Wisconsin and Canada and to the west in Iowa, Nebraska, and the Dakotas. Our Illinois records of the dark phase are from Andres, Atlas, suburbs of Chicago, Elgin, and St. Anne.

No overwintering specimens of *tritici* have ever been found out-of-doors in Illinois. Possibly this species migrates north every spring. Through the cooperation of Dr. R. J. Dysart and Mr. R. Stimson it was noted in Urbana, during the spring of 1964.



Fig. 111.—Distribution of *Frankliniella tritici* in Illinois.

that *Frankliniella tritici* suddenly appeared in wind traps at the same time the supposed southern migrant, *Empoasca fabae*, the potato leafhopper was detected. Although *tritici* was present in relatively small numbers on lilac flowers in central Illinois by at least May 4, it wasn't until May 6, when there were sustained winds from the south averaging 40 miles an hour, that this thrips began to be recovered in the traps operating above the stadium on the University of Illinois campus. Both sexes of *tritici* and an occasional specimen of *Sericothrips variabilis* were taken with high numbers of *Empoasca fabae*, and they continued to be present in the traps until observations were terminated the following week.

Forbes (1892) described an experiment at Urbana in 1889 in which he

established that *Frankliniella tritici* by its feeding caused "buttoning" or blighting of strawberries, raspberries, and blackberries. In addition, ruinous scarring of roses, chrysanthemums, and other commercial cut flowers is often done by this flower thrips during feeding. Damage to row crops, beans, and cotton for example, is often attributed to *tritici* in agricultural reports.

Like some other thrips, *tritici* will bite man on occasions.

Illinois records (Fig. 111).—Collected from mid-April until mid-November in the north to early December in the extreme south, from one to several localities in every county in the state.

Frankliniella unicolor Morgan

Frankliniella unicolor Morgan (1925b: 141). ♀. Type-locality.—Clarks-ville, Tennessee.

Frankliniella andropogoni Moulton and Andre (1936:223). ♀. Type-locality.—Waukon, Iowa. Synonymized by Moulton (1948).

FEMALE (macropterous).—Length distended about 1.5 mm. Color almost entirely yellow except terminal antennal segments which become progressively darker brown. Ocellar pigment bright red.

Head elongate, prolonged forward in front of eyes. Interocellar setae long, postocular setae short. Antennal segment III with sides of pedicel straight.

Prothorax with most of the major setae long, inner pair of the major anterior setae shorter than or nearly equal to the dorsal length of the eye.

Abdominal tergite VIII with comb of setae along the posterior margin interrupted.

MALE (macropterous).—Length distended about 1.4 mm. Similar to female in color and structure. Abdominal glandular areas elongately transverse, elliptical, one each on sternites III–VII. Abdominal tergite IX with median setae shortened but not thorn-like (Fig. 45), lateral setae long.

From *tenuicornis*, the only other species of the genus in Illinois with the

fore part of the head prolonged, *unicolor* may be immediately distinguished by its nearly all-yellow coloration in the female. Males of *tenuicornis*, which are said to be yellow, have brownish gray color on the abdomen, whereas males of *unicolor* have a light yellow-colored abdomen.

Frankliniella unicolor is almost invariably found in clumps of *Andropogon gerardi* (big bluestem). At present it is limited in its distribution to patches where big bluestem grasses still exist, particularly along railroad right-of-ways and fence rows. Formerly this thrips might have been abundant throughout much of the state in original prairie wherein big bluestem was predominant.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, CALHOUN, CARROLL, CHAMPAIGN, COOK, DE WITT, DOUGLAS, HANCOCK, HENDERSON, IROQUOIS, KANE, KNOX, LAKE, LAWRENCE, LEE, MADISON, MASON, MORGAN, PIATT, PIKE, POPE, RICHLAND, SANGAMON, SCOTT, WHITE, and WILL.

Heliothrips Haliday

Heliothrips Haliday (1836:443). Type-species by monotypy.—*Heliothrips adonidum* Haliday.

Head (Fig. 112) reticulate, with a definite necklike constriction at base. Eyes large, protruding. Ocelli on slightly raised area between eyes. Antennae eight segmented, segment III elongate, last two segments forming a style, segment VIII about four times as long as segment VII; sense cones on segments III and IV simple, not forked. Mouth cone broadly rounded. Maxillary palps two segmented.

Prothorax reticulate, all setae small. Metathorax with a conspicuous V-shaped reticulate area medially. Mesospinasternum fused to metasternum. Tarsi one segmented. Always macropterous. Fore wings bulged at base, fore vein fused to costa in apical two-thirds, leading edge without bristle-like setae; fringe cilia straight.

Abdominal tergites hexagonally re-

ticulate along sides and limitedly on the meson, median pair of setae closely spaced. Abdominal sternites without accessory setae, marginal setae set anteriorly of posterior margin. Abdominal tergite VIII with a complete comb of posterior setae. Females with well-developed ovipositor; abdominal tergite X split and with major setae on extreme posterior margin. Males with transversely elongate glandular areas, one each on sternites III–VII; with four thornlike setae on tergite IX.

This genus is the sole member of the *Heliothripini* in our area which lacks stiff, bristle-like setae along the leading edge of the fore wing, bearing instead only fine setae. *Heliothrips* is also one of the few members of the *Heliothripini* in which the fore wing fringe cilia are straight rather than wavy, and in which the median setae on the abdominal tergites are placed close together.

The single representative of this genus in Illinois, *H. haemorrhoidalis*, occasionally occurred in greenhouses before the advent of the new insecticides. It has not been found in our state in recent years.

***Heliothrips haemorrhoidalis* (Bouché)**
Greenhouse Thrips

Thrips haemorrhoidalis Bouché (1833: 42). ♀, larvae. Type-locality.—Hothouses in Berlin, Germany. Crawford, J. C. (1940:90). ♂.

Heliothrips adonidum Haliday (1836: 443). ♀. Type-locality.—Hothouses in England. Synonymized by Burmeister (1838).

FEMALE (macropterous).—Length distended nearly 1.5 mm. General color dark brown. Legs, antennal segments III–V, base of VI, apex of VII, and all of VIII pale. Median portion of abdominal segment VIII, all of IX, and base of X yellowish brown to yellow. Fore wings pale gray to light tan, the posterior vein being the darkest. In teneral specimens almost all of the abdomen is bright yellow.

Head setae small (Fig. 112).

Abdominal tergite IX with four major setae on posterior margin, these setae nearly equal in length.

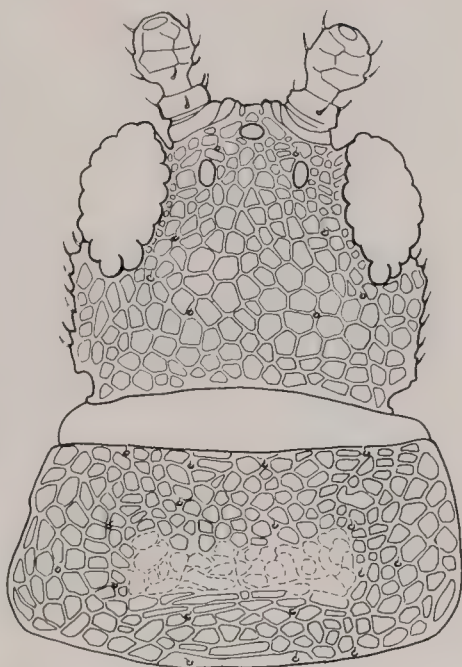


Fig. 112.—*Heliothrips haemorrhoidalis*, head and prothorax.

MALE (macropterous).—Length distended over 1.2 mm. Similar to female in color and structure with following exceptions. Antennal segments VI and VII with almost no trace of brown, abdominal tergite IX dark brown at sides and apex. Glandular areas on abdominal sternites moderately large, being largest on sternite III and decreasing in size to the smallest on sternite VII.

There appears to be considerable variation between the wild populations of the southern United States, Central America, and South America. Males from Honduras have smaller glandular areas than males from Venezuela or the West Indies. In South American populations, abdominal segment IX is more darkly colored in the female than is the case in populations from Honduras, Mexico, Florida, and California. Also there is less brown in antennal segment VI in the Honduras and Venezuela populations. Whether the abdomen is predominantly brown or yellow depends on the maturity of the adult. In teneral specimens the abdomen is invariably yellow.

Some students presume that *haemorrhoidalis* originated in tropical America and subsequently was distributed by man to other parts of the world. This seems to be a reasonable assumption in view of the presence of varied populations in the wild in the New World, and the fact that these thrips prefer many New World plants such as crotons and cacao. I have taken this species out-of-doors as far north as the Great Smoky Mountains National Park in Tennessee where they may be seasonably introduced by wind currents or other agents.

According to Russell (1909), in this species there are two larval and two pupal instars. Unlike species of *Caliothrips*, the pupal stages of *Heliothrips haemorrhoidalis* are spent on the leaves of the host plant, not underground. Males, although reportedly collected by Heeger prior to 1895 (Uzel 1895), were not described until 1940, by J. C. Crawford. Rivnay (1935) has studied the effects of various climatic factors on this thrips.

Illinois record.—LAKE COUNTY: Lake Forest, 1909, Davis, greenhouse, 4 ♀.

Hercinothrips Bagnall

Hercinothrips Bagnall (1932:506).

Type-species by original designation.—*Heliothrips bicinctus* Bagnall. Valid designation. Type-species by subsequent designation of Hood (1937).—*H. [ercinothrips] pattersoni* (Bagnall). Invalid because of prior designation.

Head strongly constricted near base. Antennae eight segmented, antennal segment III elongate, segment VIII about three times as long as segment VII. Sense cones on segments III and IV forked, although there seems to be a ventral cone on each of these segments which is simple. Maxillary palps two segmented. Prothorax hexagonally reticulate, metathorax without a raised V-shaped area, mesospinasternum fused to the metasternum. Tarsi two segmented. Hind coxae fairly close together, intermediate between the wide condition found in *Heliothrips* and the close condition

found in *Caliothrips*. Fore wing more or less pointed at tip, leading margin with a row of stout setae and a row of slender setae, both principle veins beyond fork with evenly spaced, stout setae. Abdomen hexagonally reticulate, especially along the sides. Male with three pairs of stout spines on abdominal tergite IX.

Although specialized in its own way, *Hercinothrips* may be considered the most generalized of the *Helio-Calio-Hercinothrips* group of the tribe Heliothripini. *Hercinothrips* is the only one of these three genera which still retains a two-segmented tarsus. The other two genera have the tarsal segments fused into one.

Originally the group was treated as but a part of *Heliothrips*. Later the species were transferred to *Herciothrips*, now *Caliothrips*. *Hercinothrips* was not separately categorized until 1932. Now, more than a half dozen species have been included. One of these, (*Hercinothrips femoralis*), occurs in Illinois in greenhouses where artificial tropical conditions permit it to exist. My concept of the genus is based solely on the Illinois species rather than on the type-species, but it is assumed the two are congeners and have similar basic features.

Hercinothrips femoralis

(O. M. Reuter)

Banded Greenhouse Thrips

Heliothrips femoralis O. M. Reuter (1891:166). ♀. Type-locality.—Helsinki (Helsingfors), Finland, in hothouses. White (1916:9). ♂. Transferred to *Hercinothrips* by Bagnall (1932).

Heliothrips cestri Pergande (1895:390) ♀. Type-locality.—Not stated, but possibly Washington, D. C., in greenhouse. Synonymized by Uzel (1895).

FEMALE (macropterous) (Fig. 113).—Length distended about 1.6 mm. General color dark brown. Head, thorax and terminal segments of abdomen lighter, in spots yellowish brown to yellow. Legs yellow, except mid and hind femora which are brown. Antennal segments I and II concolorous



Fig. 113.—*Hercinothrips femoralis*, dorsal aspect. From White (1916).

with head, segments III and IV and most of V except apex light yellow, apex of V and all of VI–VIII brown. Fore wing with a brown spot above scale, a broad median brown band, and subapical brown band; remainder of wing pale. Body setae pale yellow.

Head setae moderately developed but not long.

Metascutum hexagonally reticulate medially, longitudinally striate laterally.

Abdominal tergite VIII with posterior comb of setae interrupted medially, tergite IX split for nearly entire length along the median line.

MALE (macropterous).—None present in the collections of the Illinois Natural History Survey. White (1916) reported that the male is similar to the female in color and general structure. Characteristics of abdominal sternal glandular areas, if any, not known to me. Abdominal tergite IX with three pairs of stout spines (Fig. 42).

Superficially this species resembles *Heliothrips haemorrhoidalis*, but the two can be readily separated even with a hand lens by their color. *Hercinothrips femoralis* has darker legs and wings than *Heliothrips haemorrhoidalis*.

Unlike *Heliothrips haemorrhoidalis*, *femoralis* may have been introduced into the New World. Although it is often found out-of-doors in the warmer zones, it does not seem to occur regularly on native North American plants but rather stays on cultivated plants. It is especially fond of sugar beets. Originally the sugar beet came from the Mediterranean and eastward and the provenience of its thrips, *femoralis*, may be the same. I have never taken this thrips, as I have *haemorrhoidalis*, in natural woodlands on our continent.

Before modern insecticides became widely used, *femoralis* was frequently found in greenhouses in Illinois. Now it and the other greenhouse species are rare in this state.

White (1916) has studied the biology of this thrips. According to his reports, it pupates on the leaves, as does *Heliothrips haemorrhoidalis*, and not in cracks in the ground, as do species of *Caliothrips*.

Illinois records.—CHAMPAIGN COUNTY: Urbana, September 2, 1932 to June 30, 1934, Compton, Farrar, on many plants in greenhouse, many ♀; Urbana, July 16, 1959, Stannard, in

greenhouse, many ♀, larvae. FULTON COUNTY: Canton, September 23, 1932, Compton, snapdragons in greenhouse, 2 ♀. JACKSON COUNTY: Murphysboro, April 12, 1932, Compton, snapdragons and zinnias in greenhouse, 2 ♀. MCLEAN COUNTY: Bloomington, January 13, 1928, Compton, calla lily, 2 ♀. STEPHENSON COUNTY: Freeport, September 13, 1933, Compton, on chrysanthemum, 14 ♀.

Iridothrips Priesner

Iridothrips Priesner (1940:403). Type-species by original designation.—*Bregmatothrips iridis* Watson.

Head bulged considerably in front of eyes. Antennae eight segmented. Antennal segments III and IV with simple sense cones. Ocelli always present. Mouth cone bluntly rounded. Maxillary palps three segmented, labial palps two segmented.

Prothorax with anterolateral pair and the two epimeral pairs of setae long, midanterior pair and midposterior pair not as long but well devel-

oped. All lateral pronotal setae small. Mesospinasternum separated from metasternum by suture. Metaspinasternum truncate (Fig. 98). Fore legs not enlarged. All tarsi two segmented. Macropterous or brachypterous. Fore wings with two veins, setae on both veins uniformly spaced; fringe cilia wavy.

Abdomen with pleural plates. Median pairs of setae placed far apart on the intermediate abdominal tergites. Abdominal sternites without accessory setae in addition to posterior ones. Abdominal segment X longer than segment IX. Males bearing elliptical glandular areas on abdominal sternites III–VII.

This genus is monobasic.

Seemingly *Iridothrips* is the biological equivalent of *Bregmatothrips*, but it is doubtful that they are closely related. Their superficial resemblance is probably due in part to parallel evolutionary development and in part to inheritance from a distant common ancestor. The differences between these genera are listed, in part, in the following tabulation:

Characteristic	Bregmatothrips	Iridothrips
OCELLI	Often absent in brachypterous forms	Always present in all forms known (Male not described)
MOUTH CONE	Pointed	Bluntly rounded
METASPINASTERNUM	Pointed (Fig. 97)	Truncate (Fig. 98)
MAJOR ANTERO-PROTHORACIC SETAE	Mesad of anterolateral corner	At anterolateral corner
FORE VEIN OF FORE WING	With interrupted row of setae	With evenly spaced row of setae
ABDOMINAL SEGMENT X	Shorter than segment IX	Longer than segment IX
♂ ABDOMINAL STERNAL GLANDS	Absent	Present

***Iridothrips iridis* (Watson)**

Iris Thrips

Bregmatothrips iridis Watson (1924c: 253). ♀. Type-locality.—Bassenheim, Holland. Transferred to *Iridothrips* by Priesner (1940). Smith (1933:916). ♂.

FEMALE (macropterous).—Length distended over 2 mm. General color dark brown. Yellow: base of head, antennal segments III and IV, fore tibiae, and all tarsi. Brownish yellow: antennal segment V usually, and anterior and sides of prothorax. Body with orange-yellow subintegumental pigment. Wings pale yellow.

Head with interocellar setae moderately well developed, these setae almost as long as anterolateral prothoracic setae.

Pronotum with four or five minor and one major pair of setae on posterior margin between the epimeral setae. Metanotum with median pair of setae placed far behind anterior border.

Abdominal segment VIII with a posterior comb of tiny, toothlike setae, each of which is as broad at the base as it is long. Abdominal segment X almost entirely split along the length of the dorsum.

FEMALE (micropterous).—Not available to me; present in England (Morison 1948).

FEMALE (brachypterous).—Length distended nearly 2 mm. Colored as in macropterous forms except yellow areas often with some brown.

MALE (brachypterous).—Length distended about 1.2 mm. Color lighter than in female, antennal segment V generally yellow, prothorax predominantly yellowish brown. Similar to female in structure except wing pads almost entirely reduced, abdominal sternites III–VII with small median elliptical glandular areas, and abdominal tergite IX with two median pairs of stout setae, the middle pair being the shortest.

The differences between *Iridothrips iridis* and species in the morphologically similar genus *Bregmatothrips* are outlined in the generic diagnosis of *Iridothrips*.

By the setation of the prothorax, form of head, and close similarity of color, *I. iridis* superficially resembles *Frankliniella tenuicornis*. Use of several characteristics, however, permits the immediate separation of these two species. In *I. iridis* antennal segments III and IV bear simple sense cones, the median pair of setae on the metanotum are placed far posterior of the anterior border, and the ocelli are always small. By contrast, in *F. tenuicornis* antennal segments III and IV bear forked sense cones, the median pair of metanotal setae are placed along the anterior border, and the ocelli are medium in size.

Originally this species was discovered in 1923 in quarantine at New York on iris sent from Holland and England. Later, in 1927, Moulton reported "the first finding of this species (out-of-doors) in the United States" based on two specimens collected at Urbana, Illinois. Since then no other specimens have been taken in Urbana or anywhere else in Illinois. Subsequently it has been found in New Hampshire, Massachusetts, New Jersey, Pennsylvania, Maryland, Virginia, Ohio, Washington, Oregon, and again in New York (Smith & Utter 1937). Apparently this thrips has become established on the eastern and western coasts of North America, but despite one, or possibly more, introductions it has not persisted in Illinois or other midcontinental states.

Smith & Utter (1937:6) advanced and supported the logical theory that the original home of the iris thrips was Europe, and its original host was the European yellow flag (*Iris pseudacorus*).

Illinois record.—CHAMPAIGN COUNTY: Urbana, (Moulton 1927b).

***Leucothrips* Reuter, O. M.**

Leucothrips Reuter, O. M., (1904:107). Type-species by monotypy.—*Leucothrips nigripennis* Reuter, O. M.

Microthrips Morgan (1913:19). Type-species by original designation.—*Microthrips piercei* Morgan. Synonymized by Hood (1931b).

Head (Fig. 114) wider than long. Eyes protruding. Ocelli present, all nearly equal in size. Antennae seven segmented, segments III and IV with single sense cones. Maxillary palps two segmented, labial palps two segmented.

Pronotum with a transverse submedian ridge. Only posterior pronotal setae well developed, with the two epimeral setae the longest. Mesospi-nasternum fused to metasternum. Metafurcae enormously developed. All tarsi one segmented. Fore femora not enlarged. Fore wings slender, with but one longitudinal vein set with a few scattered setae, several at base and several near apex; fringe cilia straight, not wavy.

Abdomen without microsetae except on terminal segments. Pleural plates seemingly present but difficult to see. Abdominal sternites without accessory setae in addition to the posterior ones. Males without abdominal projections other than setae. Females with downturned ovipositor.

Hood (1931b) sank *Microthrips* under *Leucothrips* Reuter chiefly because both had but seven segments in each antenna and because both lacked microsetae (microtrichae) on the abdominal tergites. At the same time this author noted that the type-species of *Leucothrips*, *nigripennis*, as well as several other species, could be characterized by the structure of the sense cones on antennal segments III and IV. In the *nigripennis* group these sense cones are forked, whereas in the type-species of *Microthrips*, *piercei*, these sense cones are single.

Inadvertently, Priesner in his monograph (1926b) recorded that *Leucothrips nigripennis*, a species not then available to him, bore eight segments (rather than seven) in each antenna. He corrected this statement in his *Genera Thysanopterorum* (1949). Meanwhile, however, Morison (1948) also erroneously characterized this genus as having eight segments in each antenna. One species, currently assigned to *Leucothrips*, *pictus* Hood from Brazil, does have eight-segmented antennae, but in the other

congeners, including the type-species *nigripennis*, there are only seven segments.

Bailey (1957) has presented a key to the five known species of the world. Probably all the species, even *nigripennis* which was originally found in a greenhouse in Finland, are of New World origin.

Leucothrips belongs to a complex of other similarly formed genera such as *Pseudodendrothrips*, *Halmathrips*, and *Graphidothrips*. All of these taxa need to be compared and redefined for a better understanding of the significant characteristics of each.

The sole representative of this genus in Illinois is *piercei*.

Leucothrips piercei (Morgan)

Microthrips piercei Morgan (1913:19).

♀. Type-locality.—Dallas, Texas.

Transferred to *Leucothrips* by Hood (1931b).

FEMALE (macropterous).—Length distended nearly 0.8 mm. Color almost entirely white with a faint underlying hue of yellowish gray, apices of apical antennal segments pale brown, ocellar crescents bright red.

Head and prothorax as in Fig. 114.

Pronotum evenly and closely transversely striate, metascutum evenly

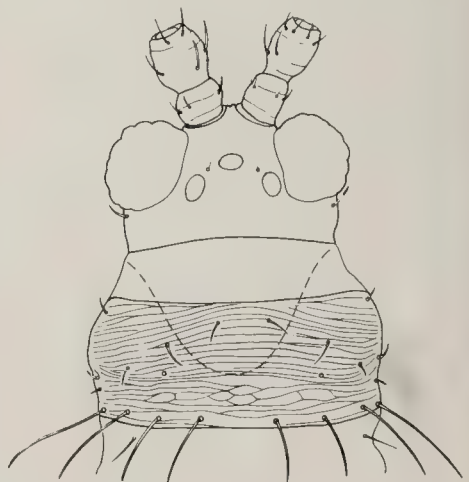


Fig. 114.—*Leucothrips piercei*, head and prothorax.

and closely longitudinally striate. Abdominal tergites VIII and IX each with a complete, uninterrupted posterior row of setae.

MALE (macropterous).—Length distended about 0.7 mm. Similar to female in color and structure. Apparently no abdominal sternal glandular areas present. Lateral regions of male genital capsule greatly enlarged.

Most Illinois specimens of this species have been taken from the undersides of leaves of redbud trees, which may be the thrips' principal hosts in our area. A female taken in late May was found to have a fully developed egg in her abdomen and a female taken in late June from a more northern locality had a partially developed egg. A series of associated larvae were found during the last week of May in southern Illinois. Obviously these thrips are active in the spring and not just in the late summer or early fall as has been implied by others. Adults overwinter in the litter of the forest floor.

I have examined specimens collected from Michigan to Chiapas, Mexico and Key West, Florida. As yet I have been unable to find any significant differences between the representatives of these widely spread populations, and, although it is very unusual, possibly these many specimens collected from the near tropics to the near Canadian zone belong to the same entity. Bailey (1957) also records *piercei* as being in California, South America, Hawaii, and elsewhere.

Illinois records (Fig. 24).—Collected during spring and summer, from one to several localities in the following counties: BOND, CALHOUN, CHAMPAIGN, CLARK, CLINTON, COLES, FRANKLIN, FULTON, GALLATIN, GREENE, HAMILTON, HARDIN, JACKSON, JASPER, JERSEY, JOHNSON, LAWRENCE, MACON, MCLEAN, MACOUPIN, MARION, MASSAC, MENARD, MONROE, MONTGOMERY, MOULTRIE, PERRY, PIATT, PIKE, PUTNAM, SALINE, SANGAMON, SCHUYLER, ST. CLAIR, UNION, VERMILION, WABASH, and WASHINGTON.

Limothrips Haliday

Thrips subgenus *Limothrips* Haliday (1836:444). Type-species by subsequent designation by Westwood (1839).—*Limothrips cerealium* Haliday. Valid. Type-species by subsequent designation by Morison (1949).—*Limothrips denticornis* Haliday. Invalid, prior designation by Westwood. Raised to full generic rank by Amyot and Serville (1843).

Head longer than wide (in Illinois), prolonged in front of eyes. Interocellar and postocular setae small. Ocelli present in macropterous forms, absent in apterous forms. Antennae eight segmented, segments II and III either not produced, slightly produced, or greatly produced. Sense cones on antennal segments III and IV simple or forked. Maxillary palps two segmented.

Prothorax with only one pair of well-developed epimeral setae, all other setae small. Mesospinasternum separated from metasternum by a wide suture. Tarsi two segmented. Females macropterous, males apterous. Fore wings with two longitudinal veins; fore vein with setae interrupted, hind vein more or less evenly set with setae; fringe cilia wavy.

Abdominal tergites with median setae set far apart. Abdominal sternites with accessory setae. Abdominal tergite VIII without a comb of posterior marginal setae. Abdominal segments VIII–X often with setae thickened or thornlike. Female with well-developed ovipositor, always with a pair of thornlike setae on abdominal tergite X. Males frequently with small, circular, glandular areas on abdominal sternites III–VII, with median and lateral setae on abdominal tergite IX reduced and thornlike, and abdominal segments IX and X forming a large semicircular unit.

This genus bears resemblance to *Bregmatothrips*, *Chirothrips*, *Iridothrips*, *Plesiothrips* and others. It can be distinguished from any of these and from any other genus in Illinois by the paired thornlike setae on abdominal tergite X as found in the female.

In 1942, Shumsher erected the genus

Pruthiella for *Limothrips angulicornis*. Because *angulicornis* is not an Illinois species, I have not as yet formed an opinion on Shumsher's proposal; however, *angulicornis* is arbitrarily included in the accompanying key to the North American *Limothrips*-like species.

Two species, *cerealium* and *denticornis*, occur in our state (Fig. 115).

KEY TO SPECIES
(OF NORTH AMERICA)

1. Antennal segment II produced at outer apex; antennal segment III not at all produced, with forked sense cone; not found in Illinois. *angulicornis*
Antennal segment II not produced at apex; antennal segment III greatly produced or slightly produced at outer apex, with a simple sense cone. 2
2. Antennal segment III greatly produced at apex, sense cone not on angle of antennal projection. *denticornis*
Antennal segment III only slightly produced or not produced at apex. 3
3. Antennal segment III only slightly produced at apex, sense cone on angle of antennal projection. *cerealium*
Antennal segment III not produced; not found in Illinois; present in North Dakota. *consimilis*

***Limothrips cerealium* (Haliday)**
Grain Thrips, Oats Bug

Thrips (Limothrips) cerealium Haliday (1836:445). ♀, ♂. Type-locality.—England.

Limothrips avenae Hinds (1902:139). ♀, ♂. Type-locality.—Not given but either in Pennsylvania or Massachusetts. Synonymized by Bag-nall (1908c).

FEMALE (macropterous).—Length distended about 1.9 mm. General color dark brown. Intermediate antennal segments, especially segment III, light brown, sometimes becoming yellowish brown. Apex of each tibia and all tarsi yellowish brown to yellow. Fore wings brown except for white spot near base. Ocellar pigment red. Body with yellow subintegumental pigment.

Head not prolonged as far as in *denticornis* (Fig. 116). Antennal segment II not produced at apex, antennal segment III only slightly produced at apex. Sense cones on antennal segments III and IV simple, cone on segment III on tip of slight projection.

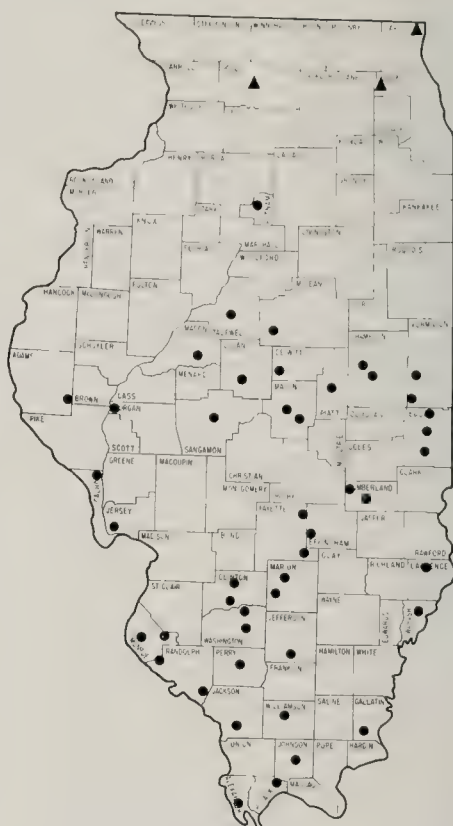


Fig. 115.—Distribution of species of *Limothrips* in Illinois: *Limothrips cerealium* (circular dots) and *Limothrips denticornis* (triangular marks).

Prothorax proportionately longer than in *denticornis*. Metascutum weakly sculptured.

Abdominal sternites with accessory setae arranged more or less in a single transverse row. Major setae on abdominal tergite IX slender, not shortened or spinelike.

MALE (apterous).—Length distended about 1.5 mm. Similar to female in color except intermediate antennal segments and legs more yellowish brown. Similar to female in structure with the following exceptions. Ocelli absent, thorax typical of apterous conditions, without wing sclerites and with notal areas simplified. Abdominal sternites III–VII each with a small, nearly circular, glandular area (Fig. 46). Abdominal tergite IX with each lateral spine socket produced to appear as a second spine, posterior

margin not as thickened as in *denticornis*.

This species differs markedly from *denticornis* in many features such as those mentioned in the key, and also in the extent of prolongation of the head, the arrangement of the accessory setae on the abdominal sternites, and the structure of abdominal tergite IX, particularly the setae. One characteristic, the small projection of antennal segment III, serves to distinguish *cerealium* immediately from *denticornis*, which, by contrast, bears a large projection on segment III.

Limothrips cerealium is undoubtedly an introduced species from Europe. It inhabits most of Illinois south of an imaginary line connecting Rock Island and Chicago. It causes damage to cereal grains, but in Illinois no special attempts are made to control its populations. In certain years, in late June or early July, enormous flights of these insects occur, at which time they cause annoyance by biting people and entering houses.

The life history of this thrips was described by Korting (1930).

Illinois records (Fig. 115).—Collected every season of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, CALHOUN, CHAMPAIGN, CLARK, CLINTON, CUMBERLAND, DE WITT, EDGAR, EFFINGHAM, FAYETTE, GALLATIN, JACKSON, JEFFERSON, JERSEY, JOHNSON, LAWRENCE, LOGAN, MACON, MARION, MASON, MCLEAN, MONROE, MORGAN, PERRY, PIATT, PULASKI, PUTNAM, RANDOLPH, ST. CLAIR, SANGAMON, TAZEWELL, VERMILION, WABASH, WASHINGTON, and WILLIAMSON.

***Limothrips denticornis* Haliday** The Barley Thrips

Thrips (Limothrips) denticornis Haliday (1836:445). ♀, ♂. Type-locality.—England.

Thrips kollari Heeger (1852:485). ♀. Type-locality.—Austria. Synonymized by Uzel (1895).

Thrips (Limothrips) bidens Reuter, O. M. (1878/79:218). ? ♀. Type-locality.—Pargass (Parainen), Tur-

ku-Pori, Finland. Synonymized by Uzel (1895).

Thrips secalina Lindeman (1887:302). ♀, ♂. Type-locality.—Not given but possibly Moscow, U.S.S.R. Synonymized by Uzel (1895).

FEMALE (macropterous).—Length distended over 2 mm. General color dark brown. Pedicel of antennal segment III, tip of each fore tibia, and all tarsi yellow. Fore wings brown becoming slightly lighter near base. Ocellar pigment red.

Head (Fig. 116) more prolonged in front of eyes than in *cerealium*. Antennal segment II not produced at apex. Antennal segment III greatly produced at apex. Sense cone on antennal segment IV forked; sense cone on segment III simple, not placed at tip of projection.

Prothorax (Fig. 116) proportionately shorter than in *cerealium*. Sculpture of metascutum moderately strong.

Abdominal sternites with accessory

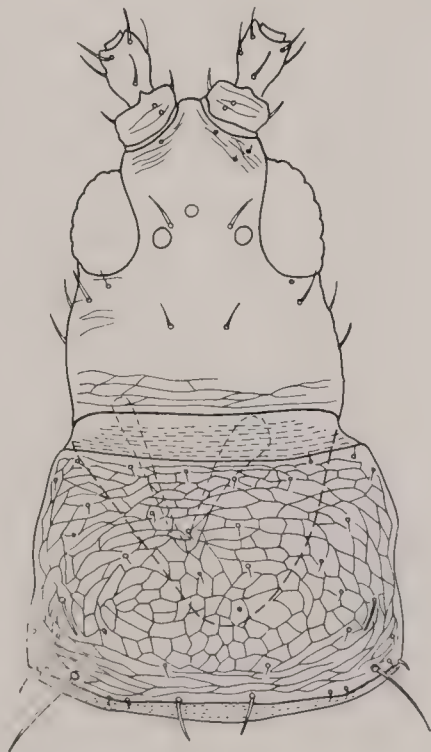


Fig. 116. —*Limothrips denticornis*, head and prothorax.

setae scattered across the segments. Major setae on abdominal tergite IX thickened, nearly spinelike, middle pair somewhat shortened.

MALE (apterous).—Length distended about 1.5 mm. Similar to female in color except antennal segment III yellow to nearly white. Similar to female in structure with the following exceptions. Ocelli absent. Thorax typical of apterous conditions, without wing sclerites, and with notal areas simplified. Abdominal sternites seemingly without glandular areas (in specimen available to me). Abdominal tergite IX with each lateral setal socket not produced to appear as a second spine, posterior margin thickened.

This species can be easily recognized by the large angular production of the outer apex of antennal segment III.

Limothrips denticornis occurs only in the northern counties of Illinois. Elsewhere it is found in many northern states, and in countries of the Holarctic Realm.

Bournier (1956a) has summarized the reports on the precocial mating behavior of this thrips. In North Dakota it does considerable damage to barley (Post 1959), where it is estimated populations reach up to 24 million thrips per acre on this crop (Post & Olson 1960).

Illinois records (Fig. 115).—**COOK COUNTY**: east of Elgin (Shoefactory Road hill prairie), October 10, 1952, Ross, Stannard, *Andropogon*, 1 ♀. **LAKE COUNTY**: unknown locality, October 23, 1949, Decker, sod of *Andropogon gerardi*, 2 ♀; Wauconda, March 16, 1933 and October 28, 1943, Ross, Frison, Mohr, Sanderson, litter in tamarack bog, 9 ♀. **OGLE COUNTY**: Castle Rock, December 9, 1932, Frison, Ross, ground cover, 1 ♀; White Pines State Park, December 9, 1932, Frison, Ross, under pines, 1 ♀.

Microcephalothrips Bagnall

Microcephalothrips Bagnall (July 1926b:113). Type-species by original designation.—*Thrips abdominalis* Crawford, D. L. *Stylothrips* Karny (September 1926:

205). Type-species by monotypy.—*Stylothrips brevipalpus* Karny. Preoccupied by *Stylothrips* Bondar (1924). Synonymized by Priesner (1949).

Thrips subgenus *Ctenothripella* Priesner (1927:442). Name without an independent published description but validated by virtue of being recognized upon erection as a synonym of *Microcephalothrips*.

Paraphysopus Girault (1927:2). Type-species by original designation.—*Paraphysopus burnsi* Girault. Synonymized by Priesner (1949).

Head small, slightly wider than long. Eyes proportionately large. Ocelli placed fairly far apart. Interocellar and postocular setae small. Antennae seven segmented, segments III and IV each with a forked sense cone. Mouth cone moderately developed. Maxillary palps three segmented.

Prothorax with most setae small, inner epimeral pairs small but slightly longer than the others; with five or six pairs of setae along posterior margin of the prothorax between the epimeral pairs. Mesospinasternum separated from metasternum by a wide suture. Metascutum longitudinally striate. All tarsi two segmented. Fore wings bowed, with two longitudinal veins, hind vein uniformly set with setae, fore vein with setae interrupted, cilia wavy.

Abdomen with well-separated pleural plates. Abdominal sternites with accessory setae. Most abdominal tergites with strong scallop-like projections on each posterior margin. Median pair of setae placed far apart on the intermediate abdominal tergites. Female with well-developed ovipositor, with abdominal tergite X almost completely split. Males with a glandular area on abdominal sternites III–VII, without thornlike setae on abdominal tergite IX.

During the course of its taxonomic history, this genus has been occasionally placed as a subgenus of *Thrips*. Although close to *Thrips*, *Microcephalothrips* is distinctive by several features. Species of *Microcephalothrips* have the major posterior prothoracic setae greatly reduced in size, and be-

tween these setae there are at least five pairs of smaller setae. By contrast the species of *Thrips* have much longer major posterior prothoracic setae, and between these setae there are only two, three, or rarely four pairs of smaller setae. Also in *Microcephalothrips* the scallop-like projections are larger and occur along the posterior margins of most of the abdominal tergites. In the species of *Thrips* which possess scallop-like projections, the projections are much smaller and are much less prominent to absent on the anterior tergites.

The cosmopolite, *abdominalis*, is the only species present in Illinois.

Microcephalothrips abdominalis

(Crawford, D. L.)

Composite Thrips

Thrips abdominalis Crawford, D. L. (1910:157). ♀. Type-locality.—Guadalajara, Mexico. Moulton (1929b:236). ♀. Transferred to *Microcephalothrips* by Bagnall (1926b).

Thrips femoralis Jones (1912:4). ♀. Type-locality.—Barnesville, Georgia. Homonym of *Thrips femoralis* Blanchard (1851). Synonymized by Hood (1912a).

Thrips (Ctenothripella) gillettei Moulton (1926b:126). ♀. Type-locality.—Fort Collins, Colorado. Synonymized by Moulton (1929b).

FEMALE (macropterous).—Length distended about 1.2 mm. General color brown. Intermediate antennal segment, apex of fore femora, and all tarsi lighter, becoming yellow brown to yellow. Fore wings nearly uniformly brown. Body with orange subintegumental pigment. Ocellar pigment red.

Head small (Fig. 117). Antennae short.

Prothorax elongate, moderately setose.

Abdominal tergite II with three setae on each lateral margin. Accessory setae of abdominal sternites arranged in several transverse rows. Abdominal tergite VIII with setae borne at the tips of the scallop-like projections.

MALE (macropterous).—Length distended about 1 mm. Except for head, which is brown, lighter in color



Fig. 117.—*Microcephalothrips abdominalis*, head and prothorax.

than female. Legs with much yellow. Abdomen with scallop-like projections along the margins of most of the sternites as well as the tergites. Abdominal sternites III–VII each with a small, circular, glandular area.

This species occurs throughout Illinois on many flowers, particularly composites. It may be a New World thrips with a natural range covering most of North America. It also occurs in such widely scattered places as Fiji, Hawaii, India, and elsewhere, possibly having been transported to these places by man. Its life history has been described by Bailey (1937) and Jagota (1961).

The names *Thrips crenatus* Watson and *Thrips oklahomae* Watson may apply to the species *abdominalis* or to closely related species.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, CARROLL, CASS,

CHAMPAIGN, CLARK, COLES, COOK, EDGAR, GALLATIN, JACKSON, JEFFERSON, JO DAVIESS, KANKAKEE, LAKE, LAWRENCE, MORGAN, PIATT, PIKE, POPE, PUTNUM, RICHLAND, UNION, VERMILION, and WILL.

Odontothrips Amyot and Serville

Odontothrips Amyot and Serville (1843:642). Type-species by subsequent designation by Karny (1907).—*Thrips phalerata* Haliday.

Head moderate in size, similar to the higher Thripidae such as *Frankliniella*, *Taeniothrips* and *Thrips*. Ocelli present. Antennae eight segmented with the last two segments forming a style. Antennal segments III and IV with forked sense cones, segment VI with base of sense cone small or greatly enlarged. Maxillary palps three segmented, labial palps two segmented.

Prothorax with only the two pairs of epimeral setae greatly elongated. Mesospinasternum separated from metascutum by a wide suture. Fore tibiae each with one or two clawlike processes at apex. All tarsi two segmented. Always macropterous. Fore wings with two veins, setae on fore vein interrupted subapically.

Abdomen with pleural plates. Tergites and sternites without microsetae. Abdominal tergites without posterior comb of setae except weakly and sparsely on tergite VIII. Abdominal sternites without accessory setae. Abdominal tergite X of female with an incomplete longitudinal split. Males without glandular areas and with or without a pair of thornlike setae on abdominal tergite IX.

These thrips are essentially like the species belonging to *Taeniothrips* but differ principally in the characteristic of the clawlike processes at the apex of each fore tibia. In the European species of *Odontothrips* the base of the sense cone on antennal segment VI is greatly enlarged, whereas in the native American species the base of this sense cone is small.

One indigenous species, *pictipennis*, is common throughout the state. An introduced species, *loti*, may also be found here eventually.

KEY TO SPECIES

(ILLINOIS AND NEIGHBORING STATES)

1. Base of sense cone on antennal segment VI small; fore wings with a light subapical band; apex of each fore tibia with two clawlike processes (Fig. 78).
..... *pictipennis* Hood
- Base of sense cone on antennal segment VI enlarged; fore wings uniformly brown in apical half; apex of each fore tibia with one clawlike process and one heavy seta; not yet found in Illinois.
..... *loti* (Haliday)

Odontothrips loti (Haliday)

Thrips loti Haliday (1852:1108). ♀. Type-locality.—England. Transferred to *Odontothrips* by Williams (1916).

Euthrips ulicis californicus Moulton (1907:56). ♀, ♂. Type-locality.—Wrights Station, Santa Clara County, California. Transferred to *Odontothrips* by Hood (1914a). Raised to full specific rank by Moulton (1927a). Synonymized by Moulton (1929b).

FEMALE (macropterous).—Length distended about 1.8 mm. Color dark brown except antennal segments III and IV, fore tibiae and all tarsi which are yellowish brown. Fore wings uniformly brown except for a nearly white subbasal band.

Head moderately wider than long, cheeks nearly straight, fore margin only slightly prolonged. Interocellar setae well developed and long. Base of antennal segment VI broad, barely pedicellate; base of sense cone on segment VI enlarged. Mouth cone long and pointed.

Prothorax sparsely setose on notum except around margins. Apex of each fore tibia with one clawlike process and one enlarged seta.

Abdominal segments generally smooth, weakly striate only on lateral margins.

MALE (macropterous).—Length distended about 1.3 mm. General color and structure as in female. Abdominal tergite IX with median pair of setae short but not abnormally thickened or thornlike.

Undoubtedly introduced from Europe, this species has been reported in California, Colorado, and Virginia

(Moulton 1929b). I have taken it at Aurelia, Iowa and likely it may be found eventually in Illinois. Males as well as females are in North America.

In Europe this species is found on a large number of herbs and trees (Priesner 1926b). An account of its life history has recently been given by Orbtel (1963).

Odontothrips pictipennis Hood

Odontothrips pictipennis Hood (1916d: 117). ♀. Type-locality.—Great Falls, Virginia.

Odontothrips morgani Bagnall (1929b: 49). ♀. Type-locality.—Quincy, Florida, see Morgan (1913:1). New synonymy.

FEMALE (macropterous).—Length distended over 1.5 mm. Color dark brown except antennal segment III, base of antennal segment IV, fore tibiae, and all tarsi, which are yellowish brown. Fore wings pale subbasally and subapically with a brown margin at extreme base, brown band in the middle, and brown spot at the apex.

Head (Fig. 118) moderately wider than long, cheeks nearly straight, fore margin nearly straight. Interocellar setae well developed and long. Base of antennal segment VI broad, barely pedicellate; base of sense cone on segment VI small. Mouth cone moderately long and pointed.

Prothorax sparsely setose on the notum except around margins. Apex of each fore tibia with one large and one smaller clawlike process (Fig. 78).

Abdominal segments generally smooth, weakly striate only on the lateral margins.

MALE (macropterous).—Length distended about 1.2 mm. Color as in female except fore femora somewhat lighter. General structure as in female. Abdominal tergite IX with a median, widely spaced, pair of thornlike projections.

This species is found throughout the state in or near wooded areas. Mostly we have taken specimens on herbs such as violets and wild strawberries. Because we have found *pictipennis* only in the spring, it may be that this species has but a single early genera-

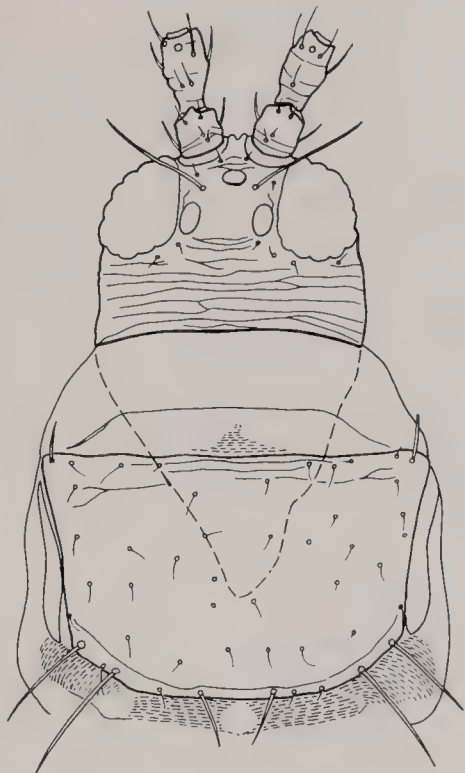


Fig. 118.—*Odontothrips pictipennis*, head and prothorax.

tion much like *Taeniothrips inconsequens*, and that like *T. inconsequens*, *pictipennis* pupates underground. By way of further speculation *pictipennis* may use its peculiar clawlike tibial processes to break out of a pupal case, if, indeed, it makes such a case.

Odontothrips morgani Bagnall is a synonym of *pictipennis*, a type specimen of which is in the U.S. National Museum. Morgan (1913) first described and illustrated this species, mistaking it for *Euthrips phalerata* Haliday. Later Bagnall (1929b), who recognized Morgan's misidentification, named it in his honor. Meanwhile, Hood (1916d) proposed *pictipennis* as the valid name.

Illinois records.—Collected from early April to mid-May, from one to several localities in the following counties: CARROLL, HARDIN, JACKSON, JOHNSON, PIATT, POPE, PUTNAM, and UNION.

Oxythrips Uzel

Oxythrips Uzel (1895:133). Type-species by subsequent designation by Hood (1916a).—*Oxythrips ajugae* Uzel.

Physothrips Karny (1912b:336). Type-species by original designation.—*Thrips ulmifoliorum* Haliday. Substituted name for *Physopus* which was emended by Uzel (1895) from *Physapus* Amyot and Serville (1843), preoccupied by *Physapus* Sultzter (1761). New synonymy.

Head wider than long to longer than wide. Antennae eight segmented, occasionally segment VI with a partial suture near apex. Antennal segments III and IV with forked sense cones. Mouth cone not greatly enlarged or extensively drawn out. Maxillary palps three segmented, labial palps two segmented.

Prothorax with one pair of epimeral setae well developed (in North America). Mesospinasternum separated from metasternum by suture. Fore legs not enlarged. All tarsi two segmented. Fore wings with two veins, setae on fore vein interrupted, setae on hind vein uniformly spaced, fringe cilia wavy.

Abdomen with pleural plates. Median pairs of setae placed far apart on the intermediate abdominal tergites. Abdominal tergite VIII without a posterior comb of setae. Abdominal segment X often elongated and pointed. In Illinois at least, males with sternal glandular areas and with two pairs of thornlike setae on abdominal tergite IX.

Physothrips Karny may be considered to be a synonym of *Oxythrips*, because the type-species of *Physothrips*, *Thrips ulmifoliorum* Haliday, is a true *Oxythrips* (Priesner 1920a). Unfortunately Karny originally thought that *ulmifoliorum* was *Taeniothrips*-like following Uzel's misidentification (Priesner 1926b), and some workers such as Prof. Dr. Priesner (1949), place *Physothrips* as a synonym of *Taeniothrips*. The problem in this case stems from the possible misidentification of a critical species. For disposition of this matter the Interna-

tional Commission of Zoological Nomenclature should be asked to decide. However, because *Physothrips* would be a synonymous name by any decision, it hardly seems worth the time and effort to probe deeper into the question and appeal to the Commission for a special ruling. I feel obliged to place *Physothrips* somewhere, and so I have placed it under *Oxythrips*.

Most of the thrips assigned to this genus are associated with pines.

These thrips are closely allied structurally to *Anaphothrips* and *Chilothrips*. In these genera antennal segment VI is often partially or completely subdivided by a secondary suture; the males usually have thornlike spines on abdominal tergite IX, and the wings have light, slender setae on the principal veins.

Another feature characteristic of *Oxythrips* is the small size of the median pair of setae on abdominal tergite IX. Most genera of the Thripidae, with the exception of wingless *Prosopothrips*, wingless *Anaphothrips*, and possibly a few others, have these setae long and well developed.

In Illinois *Oxythrips* may be distinguished from *Anaphothrips* by the chaetotaxy of the pronotum and abdominal tergite VIII. In *Oxythrips* s. str. the pronotum has one pair of well-developed epimeral setae and abdominal tergite VIII lacks a posterior comb of setae. By contrast, in *Anaphothrips* found in Illinois the prothorax lacks any well-developed setae and abdominal tergite VIII has a complete posterior comb of setae.

Specimens of *Chilothrips*, which also occur on pine, possess heavy mouth cones and by this characteristic they may be easily distinguished from representatives of *Oxythrips*.

Only one species, *Oxythrips divisus*, extends its range into Illinois.

Oxythrips divisus Hood

Oxythrips divisus Hood (1916a:39). ♀, ♂. Type-locality.—Branchville, Maryland.

FEMALE (macropterous).—Length distended nearly 1.5 mm. Color yellow except antennal segments II–VIII

and fore wings which are brown. Ocellar pigment red.

Head (Fig. 119) slightly wider than long. Antennal segment VI with a partial ventral suture apically.

Prothorax with only one major pair of epimeral setae, these setae about as long as interocellar setae; with three pairs of minor setae between epimeral pair. Each fore tarsus with an apical claw similar to that found in *Taeniothrips inconsequens*. Fore wings with three setae on the apical portion of the fore vein.

Abdominal sternites with only a few scattered accessory setae in addition to the posterior ones. Abdominal tergite VIII without a posterior comb. Abdominal segment X about $1\frac{1}{2}$ times as long as segment IX.

MALE (macropterous).—Length distended over 1 mm. Similar to fe-

male in color and general structure. Abdominal sternites III–VI each with a small circular glandular area. Abdominal tergite IX with two median pairs of stout setae, the anterior pair being the stouter.

Hitherto known only from the eastern coastal states, this species is here reported for the first time from the Mississippi valley. It occurs on yellow pine in the southwestern tip of Illinois.

Illinois record.—UNION COUNTY: Pine Hills, April 8, 1953, Stannard, sweeping *Pinus echinata*, 3 ♀, 3 ♂.

Parthenothrips Uzel

Parthenothrips Uzel (1895:170). Type-species by monotypy.—*Heliothrips dracaenae* Heeger.

Head quadrate, distinctly narrowed at base, strongly reticulate dorsally. Eyes large, protruding. Ocelli in a close triangle, not raised. Antennae seven segmented, segments III–VII slender and elongate, terminal segment threadlike; sense cones on segments III and IV simple, not forked. Mouth cone moderate in size, broadly rounded. Maxillary palps two segmented.

Prothorax reticulate; setae broad and explanate, anteromarginal and posterolateral pairs the longest. Meso- and metascutum reticulate, metascutum without a raised V-shaped area. Mesospinasternum fused to metasternum. Tarsi one segmented. Hind coxae placed fairly close together. Macropterous; fore wings broad, indented at a region after the basal third, faintly reticulate; venal setae broad and explanate; bristle-like cilia lacking on the leading edge; fringe cilia wavy on the trailing edge.

Abdominal tergite I with a prominent median line as in Fig. 120b, suggestive of a precursor of the pelta as in the Tubulifera. Most tergites with weak hexagonal reticulations on the anteromedian and lateral regions. Abdominal tergite VIII with a lamellated posterior border, without comb of setae. Abdominal tergite X, in the female, nearly entirely split, with major setae terminal. Male with abdominal sternites IV–VII each bearing a round



Fig. 119.—*Oxythrips divisus*, head and prothorax.

to oval glandular area, according to Priesner (1926b).

Principally because of its reticulate wings, *Parthenothrips* seems most closely related to the Tertiary fossil *Gerontothrips* and to the extant *Arachisothrips* and possibly *Retithrips*. By contrast *Gerontothrips* had a much broader fore wing and *Arachisothrips* has a ballooned fore wing. The monotypic *Parthenothrips* is the only broad-winged heliothripine likely to be found in greenhouses in Illinois.

***Parthenothrips dracaenae* (Heeger)**

Heliothrips dracaenae Heeger (1854: 365). ♀, ♂. Type-locality.—Vienna, Austria, in greenhouse. Transferred to *Thrips* by Regel (1858). Transferred to *Parthenothrips* by Uzel (1895).

Parthenothrips dracaenae variety *concolor* Uzel (1895:172). ♀. Type-locality.—?Bohemia (Czechoslovakia). Priesner (1926b:134). ♂. New synonymy, undoubtedly *concolor* is the teneral phase of the species.

FEMALE (macropterous).—Length distended about 1.8 mm. Body color yellowish brown, darkest in abdominal segments II–VII, with abdominal segments I and VIII–X and parts of thorax lightest. Antennal segments I–V generally yellow, segments VI and VII brown. Fore legs nearly all yellow, mid and hind femora mostly brown, mid and hind tibiae and tarsi yellow. Fore wings pale except for brown spots at regions of wing constriction and a few spots and setae along the major veins in the apical third. Body setae pale yellow.

Head (Fig. 120a) with setae small, difficult to see.

Mesoscutum more or less reticulate medially, bearing striae laterally. Metascutum with reticulations very narrowly restricted to median region.

Abdominal tergite I with pelta as in Fig. 120b. Abdominal tergite VIII with explanate posterior border but without comb of setae. Abdominal tergite X nearly entirely split longitudinally along the median line.

MALE (macropterous).—None present in collections of the Illinois Nat-

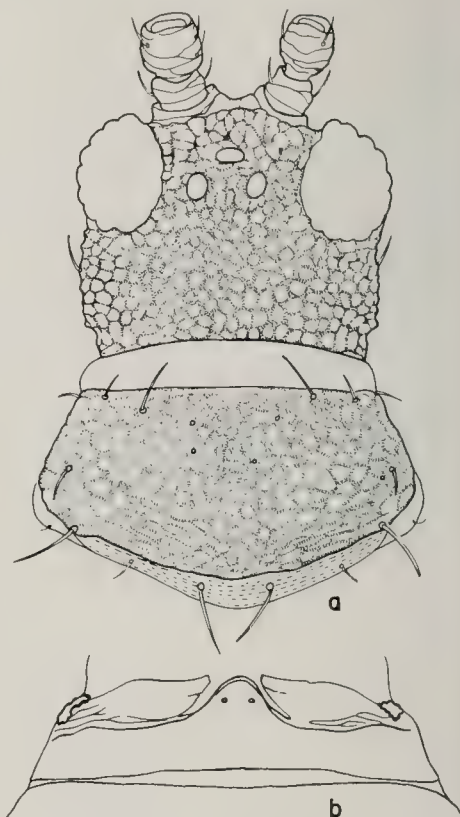


Fig. 120.—*Parthenothrips dracaenae*; a, head and prothorax; b, abdominal tergite I showing incipient pelta.

ural History Survey. Priesner (1926b) reports the male (var. *concolor*) as being smaller than the female, almost entirely yellow in color, and bearing a round-to-oblong glandular area on each of abdominal segments IV–VII.

The larvae and pupae have been described in part by Heeger (1854) and Priesner (1926b).

Possibly this thrips is indigenous to Africa, since some of its principal host plants are African, as for example *Dracaena*. As yet we have not taken it in Illinois, but since it occurs regularly in greenhouses in other states it is likely that our greenhouses may become similarly infested.

This thrips can be easily distinguished by the wide, reticulate fore wings. No other terebrantian known to be or expected to be in Illinois has such reticulations on its wings.

Plesiothrips Hood

Plesiothrips Hood (1915c:129). Type-species by original designation.—*Sericothrips* ? *perplexa* Beach.

Head about as long as wide to slightly longer than wide, prolonged in front of eyes. Antennae seven segmented (in Illinois), segment III small, segments III and IV each with a forked sense cone. Antennal segments IV–VI greatly elongated in males. Interocular setae well developed. Major postocular setae determinable only as the innermost setae varying in position from near the eyes to near the center of the head. Mouth cone moderately long, rounded at tip. Maxillary palps three segmented.

Prothorax nearly square in shape, with two pairs of epimeral setae. Mesospinasternum separated from metastutum by a wide suture. Fore legs not enlarged. All tarsi two segmented. Always macropterous. Fore wings each with two veins, setae on veins interrupted only on fore vein near apex, fringe cilia wavy.

Abdomen with pleural plates. Tergites and sternites without microsetae. Abdominal tergites without posterior combs of setae. Abdominal sternites without accessory setae in addition to posterior ones (in Illinois). Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal segment VIII of female with a red subintegumental spot. Abdominal tergite X of female with a full longitudinal split (in Illinois) (Fig. 41). Sawlike ovipositor degenerate. Abdominal sternites III and IV of males each with a pair of small, circular, glandular areas. Females (in Illinois) without abdominal sternal glandular areas. Abdominal tergite IX of males with a pair of thornlike projections on posterior margin.

The foregoing characterization of this genus pertains solely to the Nearctic species. In other regions additional characteristics may be definitive of the species involved. For instance, in parts of South America there are species with eight-segmented antennae, in Cuba and Brazil there is a species with numerous long setae on abdominal

sternites II–VII anterior to the usual posterior ones, and in Panama and Trinidad there is a species whose female bears male-like glandular areas on abdominal sternite III.

About a dozen species are now known from North and South America. Of these, three species occur in Illinois. One, *perplexus*, is an abundant, ubiquitous species of the eastern United States; the second, *andropogoni*, is a less common species being derived from the southeastern states; and the third, *ayarsi*, is the relatively rare, southwestern derivative whose relict populations are mostly confined to sand and hill prairies in our state.

A closely related genus, *Plesiopsothrips*, was described from Trinidad in 1956 by Hood.

KEY TO SPECIES

(OF THE NEARCTIC REGION)

Key based in part upon descriptions. *Plesiothrips panicus* (Moulton), which is possibly identical with *Plesiothrips perplexus* (Beach), according to Hood (1936b), and males of *Plesiothrips typhae* Hood are not included because characteristics used herein were not mentioned in the original descriptions, nor are they known to me.

1. Head (Fig. 121) and antennal segments I and II almost entirely yellow; southeastern United States..... females of *andropogoni*
- Head and antennal segments I and II almost entirely dark brown..... 2
2. Females (females of *williamsi* unknown)..... 3
- Males (males of *andropogoni* and *setiventris* unknown)..... 6
3. Abdominal sternites II–VII with numerous long setae in addition to posterior ones; Cuba..... *setiventris*
- Abdominal sternites II–VII without accessory setae in addition to posterior ones..... 4
4. Femora dark brown; Florida..... *typhae*
- Femora predominantly yellow, although sometimes fore femora darker..... 5
5. Prothorax yellow, at most only lightly clouded with brown; inner postocular setae placed forward of other postocular setae (Fig. 122); midwestern United States and Mexico..... *ayarsi*
- Prothorax brown; inner postocular setae placed medially back from or no farther forward than the other postocular setae (Fig. 123); eastern United States..... *perplexus*
6. Antennal segments IV and V without ring-joint at base; southern United States and Mexico..... *williamsi*
- Antennal segments IV and V with ring-joint at base..... 7

7. Inner postocular setae placed forward of other postocular setae. **ayarsi**
 Inner postocular setae placed medially back from or no farther forward than the other postocular setae. . . **perplexus**

Plesiothrips andropogoni Watts

Plesiothrips andropogoni Watts (1934: 24). ♀. Type-locality.—Not given in the original description but either Clemson or Rocky Bottom, South Carolina.

Plesiothrips andropogonis [sic] *watsoni* Watts (1934:26). ♀. Type-locality.—Gainesville, Florida. New synonymy, not recognized here as either a variety or a subspecies.

FEMALE (macropterous).—Length distended about 1.2 mm. Color generally yellow, head deepest yellow. Brown: antennal segment III lightly in apical half, antennal segments IV–VII, and extreme sides of abdominal segment X. Fore wings clouded with gray. Ocellar pigment red.

Head, as in Fig. 121, longer than

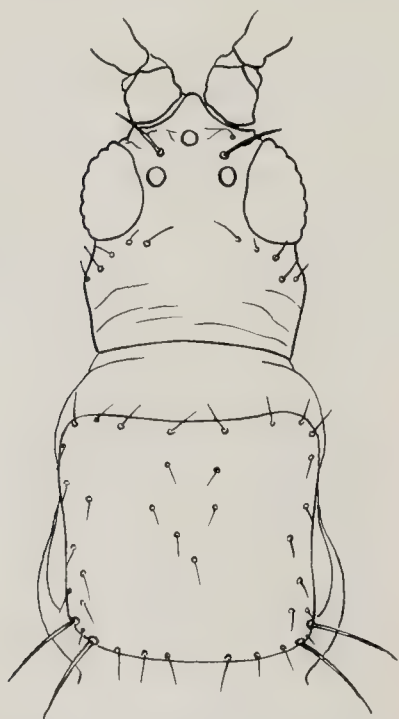


Fig. 121.—*Plesiothrips andropogoni*, head and prothorax.

wide. Inner postocular setae near eyes and in line with the other postocular setae. Antennae seven segmented.

Prothorax with three pairs of posterior marginal setae between the epimeral pairs.

Abdominal sternite III without glandular areas. Abdominal tergite X completely split longitudinally.

MALE.—Unknown.

Plesiothrips andropogoni is easily recognized from its congeners in Illinois by the yellow body color and by the yellow color of antennal segments I and II.

This is a thrips of the broom sedge (*Andropogon virginicus*). Like its host, it is confined mainly to the southeastern United States. So far *andropogoni* has been found only in southeastern Illinois in the Wabash River drainage district. Elsewhere it is known from South Carolina and Florida, and in the collections of the Illinois Natural History Survey there are specimens from Mammoth Cave National Park, Kentucky and the Florida Everglades.

Illinois records.—**LAWRENCE COUNTY**: Red Hills State Park, April 30, 1950, Smith, Stannard, sod of *Andropogon*, 11 ♀. **WHITE COUNTY**: Gossett, August 17, 1951, Ross, Stannard, sod, 2 ♀.

Plesiothrips ayarsi

Plesiothrips ayarsi Stannard (1957a: 173). ♀, ♂. Type-locality.—Fountain Bluff (Gorham), Illinois.

FEMALE (macropterous).—Length distended about 1.3 mm. Bicolored, brown and yellow. Brown: head; antennal segment I, most of segment II except apex, segment IV in apical half, segment V except pedicel, and all of segments VI and VII; posterior half of abdominal segment IX; and all of abdominal segment X. Yellow: rest of body except prothorax which is faintly clouded with brown. Fore wings pale yellowish white but with some light gray tints. Ocellar pigment red. Body with red subintegumental pigment, extended throughout most of the thorax.

Head longer than wide (Fig. 122). Inner postocular setae placed near

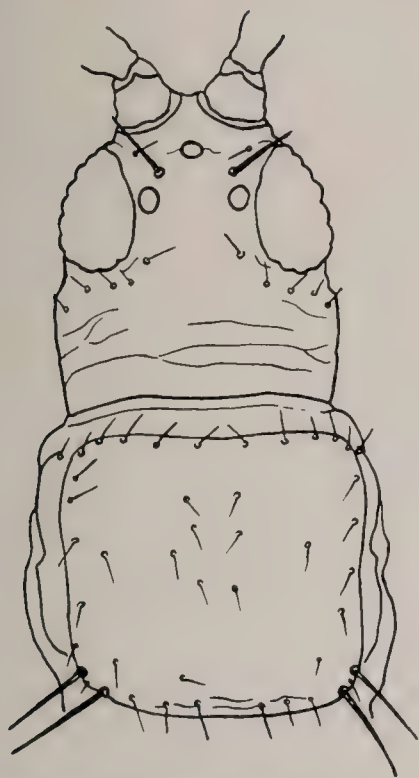


Fig. 122.—*Plesiothrips ayarsi*, head and prothorax.

eyes more anteriorly on head than are other postocular setae.

Prothorax with three pairs of posterior minor setae between the epimeral pairs.

Abdominal sternite III without glandular areas. Abdominal sternites without accessory setae in addition to posterior ones.

MALE (macropterous).—Length distended slightly over 1 mm. Darker colored than female. Almost entirely light brown with head, antennae, and terminal abdominal segments darkest and with apical portions of leg segments and anterior abdominal segments lightest.

Like the female in structure with the following exceptions. Antennal segments IV–VI enlarged as usual for males in this genus and segments IV and V each with a ring-joint. Abdominal sternites III and IV each with a pair of small, circular glandular areas. Abdominal tergite IX with the usual

two thornlike posterior marginal projections.

This species is a southwestern derivative; at least its range outside of Illinois is located entirely to the southwest. It was named for James S. Ayars, former technical editor for the Illinois Natural History Survey, who collected the only Texas specimen of this species.

From the closely related *perplexus*, *ayarsi* may be distinguished by the lighter color of the abdomen and thorax, and by the placement of the inner postocular setae. In *ayarsi* these setae are placed more forward on the head and nearer the eyes, whereas in *perplexus* they are placed farther back and more medially on the head.

In Illinois this thrips is mostly confined to sand or hill prairies. Its distribution is disjunct and suggestive of the distribution of a relict species.

Illinois records.—**COOK COUNTY:** east of Elgin (Shoefactory Road hill prairie), October 10, 1952, Ross, Stannard, prairie grasses, 1 ♀. **HARDIN COUNTY:** Karbers Ridge, August 18, 1950, Evers, Stannard, hill prairie, 1 ♀. **JACKSON COUNTY:** Gorham (Fountain Bluff), August 16, 1950, Evers, Stannard, hill prairie, 6 ♀, 2 ♂. **JOHNSON COUNTY:** Vienna, August 17, 1950, Evers, Stannard, hill prairie, 1 ♀. **MASON COUNTY:** Forest City, September 11, 1953, Ross, Stannard, sand prairie, 3 ♀. **PIATT COUNTY:** Monticello, October 3, 1939, Farrar, 1 ♀.

Plesiothrips perplexus (Beach)

Sericothrips ? *perplexa* Beach (1896: 216). ♀. Type-locality.—Ames, Iowa. Hood (1915c:130). ♀. Transferred to *Thrips* by Hinds (1902). Transferred to *Plesiothrips* by Hood (1915c).

FEMALE (macropterous) (Fig. 123).

Length distended about 1.3 mm. Colored brown with some yellow. Brown: head; antennal segment I, segment II except at extreme apex, segment V except extreme base, and all of segments VI and VII; thorax; all coxae; abdomen except for the margins of the intermediate segments. Rest of

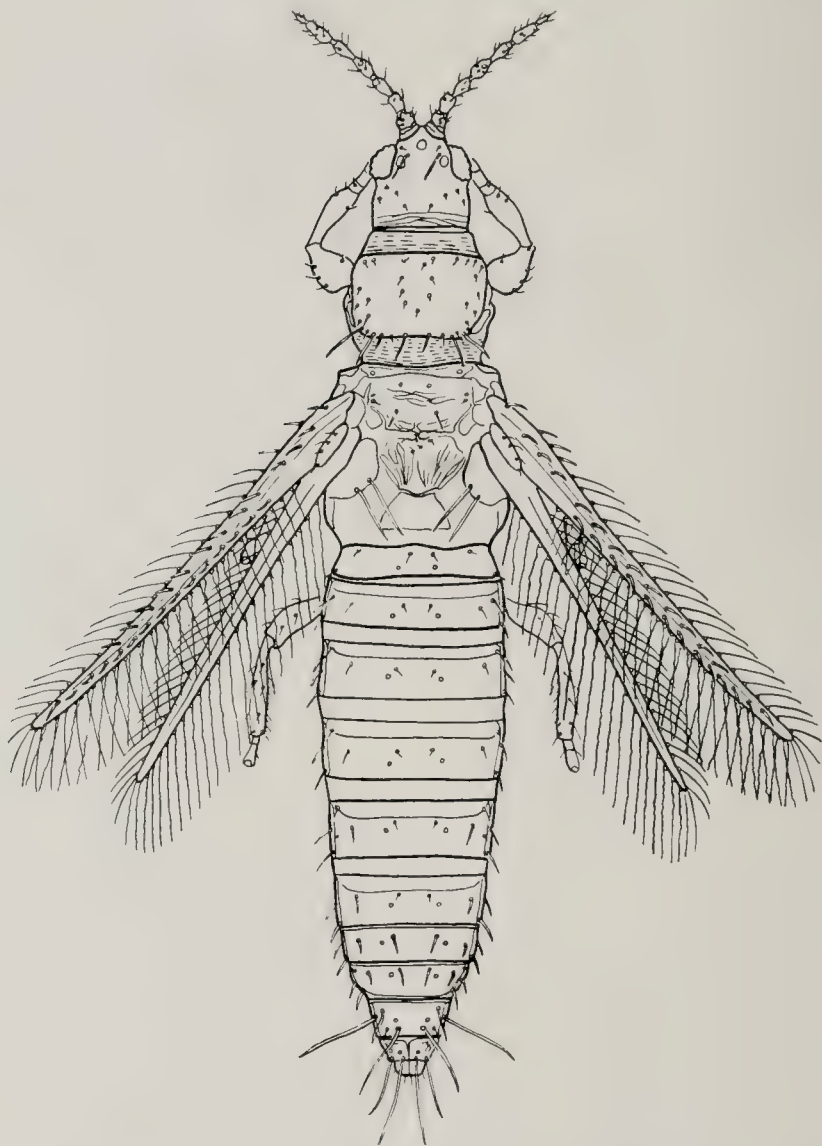


Fig. 123.—*Plesiothrips perplexus*, dorsal aspect.

body, legs, and antennae yellow. Ocellar pigment red. Fore wings heavily clouded with brown. Body, especially thorax, with much bright orange-red subintegumental pigment.

Head about as long as wide. Inner postocular setae placed medially on the head and not farther forward than the other postocular setae.

Prothorax with three pairs of minor posterior setae between epimeral pairs.

Abdominal sternite III without

glandular areas. Abdominal sternites with accessory setae in addition to posterior ones.

MALE (macropterous).—Length distended over 1 mm. Darker in color than female; only base of antennal segment III, tarsi, and apexes of tibiae yellow. General structure as in female except antennae enlarged in segments IV–VI, segments IV and V each with a basal ring-joint; and abdominal sternites III and IV each

with a pair of small, circular glandular areas. Abdominal tergite IX with the usual pair of thornlike posterior processes.

This species differs from its nearest relative, *P. ayarsi*, in color and the placement of the inner postocular setae on the head.

Plesiothrips perplexus has been recognized for a long time, yet almost nothing is known of its habits or its distributional limits except that it occurs over most of the eastern states and is found in grasses. It is found throughout Illinois.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ALEXANDER, CALHOUN, CHAMPAIGN, CLARK, COOK, CUMBERLAND, DE WITT, DOUGLAS, EDGAR, GALLATIN, IROQUOIS, JACKSON, JOHNSON, LAKE, LAWRENCE, LEE, MARION, MASON, MERCER, MORGAN, PIATT, PIKE, and WINNEBAGO.

***Pseudodendrothrips* Schmutz**

Pseudodendrothrips Schmutz (1913: 998). Type-species by monotypy.—*Pseudodendrothrips ornatissima* Schmutz.

Head much wider than long, with anterior margin inset between eyes. Eyes bulged from sides of head. Ocellar triangle located between the posterior portions of the eyes. Antennae eight segmented (abnormally nine segmented), segment II widest, segments III and IV with forked sense cones. Mouth cone moderately long. Maxillary palps two segmented.

Prothorax with striae transverse, suggestive of *Sericothrips*, postero-lateral setae with one pair well developed. Mesospinasternum separated from metasternum by a suture. Metascutum longitudinally striate. Metathoracic furcae greatly enlarged. Tarsi one segmented, hind tarsi each exceptionally elongated. Fore wings with fringe cilia straight.

Abdominal tergites laterally sculptured with transverse striae which are interspersed with fine, closely spaced, crosslines; tergites II–VIII each with a median pair of closely spaced setae;

tergite VIII with a posterior comb of setae. Ovipositor well developed in female. Males apparently without abdominal sternal glands, and without thornlike setae on abdominal tergite IX.

This genus is very similar to *Leucothrips*. In our area, besides having eight segments in the antennae, instead of seven, *Pseudodendrothrips* further differs from *Leucothrips* by having a proportionately longer tarsus in each hind leg.

Of the half dozen known species, only the introduced *Pseudodendrothrips mori* occurs in Illinois.

***Pseudodendrothrips mori* (Niwa)**

Belothrips mori Niwa (1908:180). ? ♀.

Type-locality.—Japan. Transferred to *Pseudodendrothrips* by Priesner (1938).

FEMALE (macropterous).—Length distended about 1 mm. General color white, becoming yellowish white in the head and thorax. Anterior portion of head and antennae light gray; antennal segment I lightest. Fore wings pale yellowish gray. Ocellar pigment red. Body setae colorless.

Head (Fig. 124) about twice as wide as long, deeply depressed anteriorly

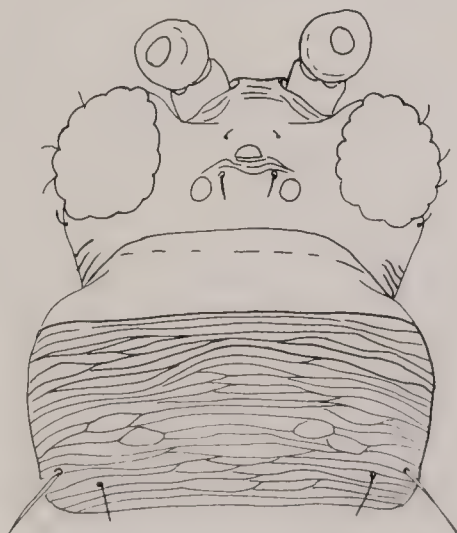


Fig. 124.—*Pseudodendrothrips mori*, head and prothorax.

between eyes. Frontal costa broad. Posterior dorsal area with broad post-occipital band. Ocellar triangle placed between the eyes. Ocellar and postocular setae minute. Mouth cone moderately long, broadly rounded. Maxillary palps each two segmented.

Antennal segments—I quadrate; II widest, globular, broadly pedicellate; III and IV each ovoid, with narrow pedicel, bearing forked sense cones; V and VI cylindrical, pedicellate; VII slender, elongate, occasionally partially subdivided; VIII slender, about half as long as VII.

Prothorax broader than long, sculptured with transverse, anastomosing striae, except for clear areas on either side of the middle, with sparsely scattered small setae; posterolateral angles each with a well-developed, pointed seta.

Pterothorax quadrate, slightly constricted between meso- and metathorax. Metascutum longitudinally striate medially, becoming somewhat hexagonally reticulate laterally. Metafurcae enlarged.

Legs slender, especially hind legs which are elongate. Tarsi each one segmented.

Fore wings with fore vein bearing about five small, major venal setae; fringe cilia straight.

Abdominal tergites II–VII laterally sculptured with transverse striae which are subdivided by fine lines; tergites II–VIII with each member of the median pair of setae placed closely together. Abdominal tergite VIII with comb complete. Abdominal tergite X seemingly entire, not split.

MALE (macropterous).—Length distended slightly over 0.6 mm. Color and structure much as in female. Abdominal tergite IX without any enlarged spinelike setae. Abdominal sternites seemingly without glandular areas.

As stated by Priesner (1938), this thrips probably originated in China or Japan, and has since been transported elsewhere. Our records bear out this contention; so far *mori* has been found only on oriental mulberries and not on our native species. J. C. Crawford first collected this thrips in the

United States in Carroll County, Maryland, in 1937. As far as I know it was not collected again until Drs. Dysart, Brooks, and Moll, then graduate students, found it abundant on *Morus alba* in and around Champaign County, Illinois in 1961. Other records have since been added in our state. According to Dr. Brooks these thrips are found most commonly on the undersides of newly formed leaves.

Illinois records.—Collected from July to late October, from one to several localities in the following counties: ADAMS, CALHOUN, CHAMPAIGN, COLES, DE WITT, DOUGLAS, FULTON, HANCOCK, IROQUOIS, JASPER, LAKE, LEE, LOGAN, MARION, MASON, McDONOUGH, MCLEAN, PIATT, PIKE, and SCHUYLER.

Pseudothrips Hinds

Pseudothrips Hinds (1902:146). Type-species by monotypy.—*Thrips inaequalis* Beach.

Head wider than long. Antennae nine segmented. Antennal segments III and IV with forked sense cones. Mouth cones not enlarged. Maxillary palps three segmented, labial palps two segmented.

Prothorax sculptured as in *Sericothrips*, with one pair of epimeral setae well developed. Mesospinasternum separated from metasternum by suture. Fore legs not enlarged. All tarsi two segmented. Fore wings with two veins, setae on fore and hind vein usually uniformly spaced, fringe cilia wavy.

Abdomen with pleural plates present but only weakly separated from the tergites. Median pair of setae on abdominal tergites I–V closely spaced. Abdominal tergite VIII with a complete comb of setae, the lateral setae of this comb frequently fused at base. Abdominal sternites without accessory setae in addition to posterior ones. Males with abdominal sternal glandular areas, thornlike setae present on abdominal tergite IX.

A characteristic of *Pseudothrips* of particular importance is the close pairing of the median abdominal setae

on the first five tergites. Priesner (1949:54) used this morphological feature as an identification aid in his key, and I believe that it can be used further as an aid in interpreting phylogenetical relationships.

It is this characteristic which permits the suggestion that *Pseudothrips* is linked to *Sericothrips*. It can be interpreted also that the presence of weakly developed microsetae on abdominal segments V–VIII in *Pseudothrips* is indicative of relationship with *Sericothrips* and that these microsetae are vestiges of the more developed condition found in *Sericothrips*.

For identification, the above-mentioned characteristic (close pairing of the median abdominal setae) allows the easy separation of *Pseudothrips* from *Psectrothrips*, a neotropical genus including *delostomae*, *beckeri*, and *spadix* (here transferred from *Pseudothrips*). *Psectrothrips* has the median abdominal setae widely spaced. In addition all the species of *Psectrothrips* have a complete or nearly complete comb of setae on the posterior margin of abdominal tergite VII whereas in *Pseudothrips* no comb is present on tergite VII.

The close pairing of the median abdominal setae is a feature which also separates *Pseudothrips* from other genera in the Thripidae, such as *Oxythrips* and *Anaphothrips*, that have nine segments in each antenna. Species in these other genera have the median abdominal setae widely spaced.

In my opinion *Pseudothrips* is a monobasic genus and all presently assigned species other than the type-species belong elsewhere or are synonyms of *inequalis* (Beach).

Pseudothrips inequalis (Beach)

Thrips inequalis Beach (1896:223). ♀. Type-locality.—Ames, Iowa. Transferred to *Pseudothrips* by Hinds (1902).

Anaphothrips (Proscirtothrips) monotropae Watson (1927b:29). ♀, ♂. Type-locality.—Gainesville, Florida. Transferred to *Pseudothrips* by O'Neill (1955). New synonymy.

Anaphothrips crassicornis Moulton

(1929b:231). ♀, ♂. Type-locality.—Champaign County, Illinois. New synonymy.

FEMALE (macropterous).—Length distended about 1 mm. Color almost entirely pale yellow except apical parts of antennal segments III–V, most of VI, and all of VII–IX, which are brown. Ocellar crescents orange.

Head with interocellar setae small.

Posterior pronotal margin with three pairs of small setae between larger epimeral pair. Metascutum hexagonally reticulate.

Abdominal segments V–VIII, at least, with occasionally weak microsetae at extreme sides.

MALE (macropterous).—Length distended about 1 mm. Color and general structure similar to female. Abdominal sternite III with a small, oval, glandular area forward of the sclerotized portion of the segment. Abdominal tergite IX with two large and two small thornlike setae.

This eastern species is found throughout the state, often on willow or basswood leaves. Its larval hosts have not yet been determined positively, but *Salix* is suspected to be one.

Illinois records.—Collected during spring and summer, from one to several localities in the following counties: ADAMS, ALEXANDER, BOONE, CHAMPAIGN (Moulton 1929b), COOK, JACKSON, JOHNSON, KNOX, LA SALLE, MONROE, OGLE, PIKE, POPE, PUTNAM, TAZEWELL, UNION, VERMILION, and WOODFORD.

Rhaphidothrips Uzel

Rhaphidothrips Uzel (1895:131). Type-species by monotypy.—*Rhaphidothrips longistylota* Uzel.

Head about as wide as long, transversely striate. Cheeks bulged behind eyes. Ocelli present, often reduced in size in the brachypterous form. Antennae eight segmented, segments III and IV with forked sense cones, segments V and VI closely joined, segments VII and VIII forming a long, slender style which is much longer than segment VI. Maxillary palps three segmented, la-

bial palps two segmented. Mouth cone fairly long.

Prothorax with only the two pairs of epimeral setae well developed. Mesospinasternum separated from metasternum by a suture. All tarsi two segmented. Macropterous, micropterous, or brachypterous. Fore wings, when well developed, with the setae on each of the two principal veins irregularly and sparsely setose, fringe cilia wavy.

Abdominal tergites and sternites without microsetae. Median pair of dorsal setae placed fairly far apart. Abdominal sternites without accessory setae in addition to the posterior ones. Abdominal tergite VIII with a posterior comb. Males with sternal glandular areas, without thornlike setae on abdominal tergite IX.

This monobasic genus was created for a species which could have been assigned to *Taeniothrips* but which, because of the peculiar, long style of the antennae, deserved special recognition.

As yet *Rhaphidothrips* is not known to be represented in Illinois. The species *longistylus* occurs in several countries in northern Europe and in Massachusetts and Connecticut.

***Rhaphidothrips longistylus* Uzel**

Rhaphidothrips longistylus Uzel (1895:131). ♀, ♂. Type-locality.—Czechoslovakia.

Rhaphidothrips fuscipennis Hinds (1902:159). ♀. Type-locality.—Massachusetts. New synonymy.

FEMALE (micropterous).—Length distended about 1.5 mm. General color dark brown. Inner apex of fore tibia and all tarsi yellow. Antennal segments III, IV, and base of V yellow to yellowish brown; antennal segments VI and VII light brown. Fore wings grayish brown. Ocellar and subintegumental body pigments reddish orange.

Head about as wide as long, slightly bulged behind eyes (Fig. 125). Ocelli present, each much larger than an eye facet. Interocellar setae fairly well developed. Postocular setae well developed.

Prothorax with transverse striae, with three pairs of small setae along the posterior margin between the ma-



Fig. 125.—*Rhaphidothrips longistylus*, head and prothorax.

jor epimeral setae. Fore wings with both principal veins sparsely setose.

Abdominal tergites transversely striate. Abdominal sternites without accessory setae in addition to the posterior ones. Abdominal tergite VIII with complete comb of irregular-sized setae. Abdominal tergite X not split.

FEMALE (brachypterous).—Similar in most respects to micropterous female except ocelli reduced in size, each about as small as an eye facet, and wings reduced to pads.

MALE (brachypterous).—Length distended about 1.2 mm. Similar to brachypterous female with the following exceptions. Ocelli as large as in micropterous female. Abdominal sternites III–VII each with a median, transversely elliptical glandular area.

By the form of the antennae, with their long styles and the close union of segments V and VI, this species can be easily distinguished from the other species in eastern North America belonging to genera near the *Taeniothrips-Thrips* complex.

Almost certainly *longistylus* has been introduced from Europe to North America. Although known from Mas-

sachusetts as early as 1902, it apparently has not spread westward from the eastern coastal area. It may or may not disperse to or become established in Illinois.

I have examined specimens from Czechoslovakia and Connecticut, the latter being from soil samples taken in a five-year-old pine plantation growing in an old field.

Scirtothrips Shull

Scirtothrips Shull (1909:222). Type-species by monotypy.—*Scirtothrips ruthveni* Shull.

Sericothripoides Bagnall (1929a:69). Type-species by original designation.—*Dendrothrips bispinosus* Bagnall. Synonymized by Hood (1935).

Head wider than long, not at all prolonged in front of eyes. Ocelli present. All head setae relatively short. Antennae eight segmented, segments III and IV with forked sense cones, segment VI not pedicellate in Illinois species. Mouth cone moderate in size. Maxillary palps three segmented.

Prothorax with one pair of posterior setae longer than any of the other marginal setae. Pronotum closely and transversely striate, with blotch region present. Mesospinasternum separated from metasternum by suture. Fore wings narrow with two longitudinal veins, fore vein with setae interrupted, hind vein with several apical setae only, fringe cilia wavy. Tarsi two segmented.

Abdominal segments I–VIII with numerous microsetae on the sides. Abdominal sternites II–VII with major setae along posterior margin. Abdominal sternites without accessory setae except for microsetae. Abdominal tergites with median pair of setae fairly closely or closely spaced. Abdominal tergite VIII with a complete comb of posterior setae. Female with well-developed ovipositor. Males apparently without glandular areas on the abdominal sternites and without thornlike setae on abdominal tergite IX.

This genus is one of the several genera in Illinois which have extensive areas of the abdomen covered by mi-

crosetae and which are not heavily reticulate. In both *Scirtothrips* and the related *Sericothrips* the antennae are eight segmented, whereas in the other close relative, *Zonothrips*, the antennae are only seven segmented. From *Sericothrips*, which has an even row of setae on the fore vein of the fore wing, *Scirtothrips* may be distinguished by its interrupted row of setae on the fore vein of the fore wing. Unlike *Sericothrips* and *Zonothrips*, *Scirtothrips* bears the major posterior setae of abdominal sternite VII along the posterior margin. These setae are borne far forward of the posterior margin (nearly in the middle of the segment) on abdominal sternite VII in *Sericothrips* and *Zonothrips*.

Three species, *brevipennis*, *niveus*, and *taxodii*, inhabit Illinois. The species *ruthveni*, although found in parts of the eastern United States, has not been recognized in our fauna. *Scirtothrips longipennis* (Bagnall) has been observed in a greenhouse in New York but, as yet, not in our state.

Priesner (1932) and Bailey (1964) have treated this genus taxonomically and presented keys.

KEY TO SPECIES

- 1. Antennal segment II decidedly brownish gray in color; on red cedar (*Juniperus*) *brevipennis*
Antennal segment II light gray, yellow, or nearly colorless. 2
- 2. Body green in life; length of hind tibia and tarsus combined only about twice the length of the prothorax; on cypress (*Taxodium*) *taxodii*
Body white to light yellow in life; length of hind tibia and tarsus combined about 2½ times the length of the prothorax; on dogwood (*Cornus*) *niveus*

Scirtothrips brevipennis Hood

Scirtothrips brevipennis Hood (1914d: 18). ♀. Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended nearly 1 mm. General color yellow to light yellow. Antennal segment I white, segments II–VIII brownish gray. Prothorax and legs clouded with gray. Fore wings gray. Abdominal tergites each with a faint brown, anterior, transverse line.

Length of hind tibia and tarsus combined more than $2\frac{1}{2}$ times the length of the short prothorax. Fore wings shorter than in *niveus*.

Abdominal tergites with median setae very closely spaced.

MALE.—Unknown.

This species can be easily distinguished from other species in Illinois by the general yellow color and by the brownish gray color of antennal segment II.

It occurs, undoubtedly, on eastern red cedar (*Juniperus virginiana*) throughout the state wherever this tree grows naturally.

Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 8, 1951, Richards, Stannard, on red cedar, 1 ♀. CALHOUN COUNTY: Batchtown, June 22, 1967, Evers, Stannard, on red cedar, 3 larvae. HARDIN COUNTY: Karbers Ridge (High Knob), August 18, 1950, Stannard, on red cedar, 1 ♀. JOHNSON COUNTY: Vienna, August 17, 1950, Stannard, on red cedar, 4 ♀. MCHENRY COUNTY: Harvard, July 28, 1960, Ross, Cunningham, on red cedar, 1 ♀. PUTNAM COUNTY: Magnolia, June 13, 1956, Glen, Selander, Stannard, on red cedar, 1 ♀.

Scirtothrips niveus Hood

Scirtothrips niveus Hood (1913b:161).
♀, ♂. Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended about 1 mm. General color nearly white to pale yellow. Antennal segment I white, segment II pale gray to almost white, segments III–VIII gray with bases of intermediate segments lighter. Fore wings pale gray, being darkest at base; occasionally wing veins tinged with red.

Length of hind tibia and tarsus combined about $2\frac{1}{2}$ times the length of the pronotum. Fore wings proportionately longer than in *niveus* and *brevipennis*.

Abdominal tergites with median setae slightly farther apart than in *brevipennis*.

MALE (macropterous).—Length distended about 0.8 mm. Similar in

color and structure to female. Abdominal sternal glandular areas apparently absent.

According to the published descriptions, *niveus* differs from the closely related *ruthveni* solely in color. Reportedly *ruthveni* is yellow, including the antennal segments. By contrast *niveus* is nearly white in the body, and antennal segments III–VIII are generally gray. Studies of the populations of both species should be made in the future to determine whether they are discrete species or merely represent color phases.

Scirtothrips niveus is found throughout the state on leaves of several species of dogwood (*Cornus*).

Illinois records.—Collected during spring and summer, from one to several localities in the following counties: CARROLL, CLARK, COOK, GREENE, JO DAVIESS, LA SALLE, ROCK ISLAND, and UNION.

Scirtothrips taxodii Hood

Scirtothrips taxodii Hood (1954a:277).
♀. Type-locality.—Reynoldsville, Georgia.

FEMALE (macropterous).—Length distended about 1 mm. Color in life generally light green. Color when preserved in alcohol generally light yellow to white. Antennal segment I white, segment II light gray, segments III–VIII gray becoming darker towards apex. Fore wings lightly clouded with gray. Ocellar pigment red.

Length of hind tibia and tarsus combined only about twice the length of the pronotum. Fore wings shorter than in *niveus*.

Abdominal tergites with median setae frequently more closely spaced than in *niveus* but not usually as closely spaced as in *brevipennis*.

MALE (macropterous).—Length distended about 0.9 mm. Similar in color and structure to female. Abdominal sternites without glandular areas. Abdominal tergite IX without thornlike setae.

This species has the shortest hind legs of the three members of the genus

in Illinois. Like *brevipennis*, *taxodii* has short wings as compared to those of *niveus*. In life, *taxodii* is green, as are most species of insects and spiders found associated with bald cypress.

Scirtothrips taxodii occurs in extreme southern Illinois on leaves of its host, bald cypress (*Taxodium distichum*).

Illinois records (Fig. 25).—ALEXANDER COUNTY: Horseshoe Lake, August 16, 1951, Ross, Stannard, on bald cypress, 11 ♀, 4 ♂, 4 larvae; Horseshoe Lake, July 17, 1947, Stannard, on bald cypress, 2 ♀. JOHNSON COUNTY: Vienna, June 14, 1934, DeLong, Ross, swept from bald cypress, 1 ♀. MASSAC COUNTY: Mermet, August 16, 1951, Ross, Stannard, on bald cypress, 2 ♀, 1 larva. POPE COUNTY: Waltersboro, August 17, 1951, Ross, Stannard, on bald cypress, 2 ♀. UNION COUNTY: Jonesboro, July 26, 1951, Sanderson, Richards, on bald cypress, 3 ♀.

Scolothrips Hinds

Scolothrips Hinds (1902:157). Type-species by monotypy.—*Thrips sexmaculata* Pergande.

Chaetothrips Schille (1910:5). Type-species by monotypy.—*Chaetothrips uzeli* Schille. Synonymized by Bag-nall (1914).

Head wider than long, slightly prolonged in front of eyes, this slight head production bearing two long setae. Ocelli on slightly raised area. Interocellar setae extremely long. Antennae eight segmented, segments III and IV each with a forked sense cone. Maxillary palps three segmented.

Prothorax with all major setae, including midlateral pair, long. Mesospinasternum separated from metasternum by a suture. Tarsi two segmented. Macropterous in Illinois. Fore wings with two veins both of which are set with long setae, fringe cilia wavy.

Abdominal tergites with median setae set far apart. Abdominal sternites without accessory setae, posterior marginal setae long. Abdominal tergite VIII without complete comb of posterior marginal setae. Female with well-developed ovipositor. Males with

large, transverse, dumbbell-shaped glandular areas, one each on abdominal sternites III–VIII. No major setae on abdominal tergite IX reduced or thornlike.

This is the only genus of the family Thripidae in Illinois whose species always bear extremely long prothoracic setae, including long midlateral setae, and exhibit two brown spots or bands on each fore wing.

In 1939 Bailey reported on the biology of one of the species and in 1950 Priesner monographed the genus for the world. As far as is known these thrips are predacious and feed on spider mites.

The proper identity of the type-species, *sexmaculatus*, was more or less established by Priesner in 1950, based upon Pergande's original description in which the extent of the dark areas of the body and wings was stated. The placement and size of these areas are now known to be diagnostic. Because Pergande had a mixture of species before him, a darker species from California and a lighter species from Washington, D.C., and thought them to represent but one species, it would be expedient to fix the type from this series to conform to the protolog and to Priesner's treatment.

Through the kindness of Miss Kellie O'Neill, permission was gained to examine Pergande's handwritten notes in the U.S. Archives and the series of cotypes in the U.S. National Museum. Based on these inquiries the lectotype of *sexmaculatus* is designated herein to be the single female specimen on the slide labeled "Thrips 6-maculata Pergande, 120/22, 4363." On page 519, Volume 6, Notes Division of Entomology, the data given by Pergande for this specimen (120/22, 4363) are: "Los Angeles, California, October 27, 1888, D. W. Coquillett, found feeding upon the red spider." The type-species is, therefore, the darker western U.S. species, and some of the other lighter specimens in the cotype series collected from Washington, D.C. are *pallidus* (Beach).

Only two species, *hoodi* and *pallidus* occur in Illinois (Fig. 126).



Fig. 126.—Distribution of species of *Scolothrips* in Illinois: *Scolothrips pallidus* (circular dots) and *Scolothrips hoodi* (triangular marks).

KEY TO SPECIES
(ILLINOIS, EXCEPT WHERE NOTED)

1. Body pale yellow without any brown markings on abdomen; basal wing band reduced to a small elliptical spot. *pallidus*
Body with brown markings especially on abdomen; basal wing band larger. 2
2. Prothorax, legs, head, and antennae largely grayish brown; prothoracic setae short, wing bands relatively small. *hoodi*
Prothorax with four brown spots; antennae, head, and legs lighter; prothoracic setae longer; wing bands smaller. This species, principally from the Southwest, has not yet been found in Illinois. *sexmaculatus*

***Scolothrips hoodi* Priesner**

Scolothrips hoodi Priesner (1950:45).
Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended about 1.5 mm. Color pale yellow with light brown markings. Most of head, antennal segments II–VIII, most of the posterior half of the prothorax, most of the pterothorax, legs, and all but the extreme sides of the abdominal tergites light brown with the antennae darkest. Fore wings with most of the scale, a broad band at the basal third, and a broad band at the apical third grayish brown. Most of the long fore wing setae brown.

Prothorax with major setae much smaller than the width of the head. Posterior part of prothorax with a pair of small median setae.

MALE.—Unknown.

This species differs from *pallidus* in the darker color and the shorter prothoracic setae.

It has been found in several localities in Illinois on certain conifers, eastern red cedar (*Juniperus virginiana*), and yew (*Taxus canadensis*).

Illinois records (Fig. 126).—ADAMS COUNTY: Lima, June 24, 1948, Stannard, on red cedar, 1 ♀; Siloam Springs State Park, June 25, 1948, Stannard, on red cedar, 1 ♀. CARROLL COUNTY: Palisades State Park, June 16, 1948, Stannard, on red cedar, 3 ♀. JO DAVIESS COUNTY: Apple River Canyon State Park, July 10, 1947, Sander-son, Stannard, on yew, 1 ♀. LA SALLE COUNTY: Utica (Clarks Run), September 16, 1958, Evers, Stannard, on red cedar, 1 ♀. MERCER COUNTY: Joy, June 18, 1948, Stannard, on red cedar, 5 ♀. PUTNAM COUNTY: Magnolia, June 13, 1956, Glen, Selander, Stannard, on red cedar, 2 ♀.

***Scolothrips pallidus* (Beach)**

Thrips pallida Beach (1896:226). ♀, ♂. Type-locality.—Not given but either Ames or Belle Plaine, Iowa, or Barraboo, Wisconsin. Transferred to *Scolothrips* by Hinds (1902).

FEMALE (macropterous).—Length distended about 1.1 mm. General color nearly white to yellow. Antennal segments III–VIII faintly clouded with pale gray. Fore wings with basal half of scale, elliptical dot at the basal

third, and a small crossband at the apical third grayish brown. Setae arising from these fore wing markings brown.

Head as in Fig. 127.

Prothorax with major setae about as long as width of head. Posterior part of prothorax with a pair of small median setae.

MALE (macropterous).—Length distended about 0.9 mm. Similar to female in color and structure. Abdominal sternites III–VIII each with a large, dumbbell-shaped glandular area. Abdominal tergite IX with major setae arranged in a transverse row.

This species, which for nearly a half century had been considered to be a synonym of *sexmaculatus*, was resurrected and properly defined by Priesner (1950). It differs from the other Illinois species, *hoodi*, by having lighter coloration and longer prothoracic setae. The southwestern species, *sexmaculatus*, among other characteristics, has dark spots on the thorax and abdomen and can be easily distinguished from the uniformly pale *pallidus*.

Scolothrips pallidus undoubtedly occurs throughout Illinois and is at

times abundant on soybeans, roses, and other crops where it feeds on spider mites. Although this predacious thrips is beneficial in that it destroys plant-eating mites, it seems to be incapable of materially reducing large populations of these mites (Bailey 1939b). Its economic value as a natural controlling force in agriculture in Illinois is unknown.

Illinois records (Fig. 126).—CHAMPAIGN COUNTY: Urbana, July 30, 1954, Snetzinger, on rose leaf with 2-spotted spider mites, 1 ♂. EFFINGHAM COUNTY: Edgewood, July 14, 1954, Ross, Stannard, on *Baptisia* in burnt prairie, 1 ♀. JACKSON COUNTY: Carbondale, September 1, 1965, Meyer, on apple trees feeding on spider mites, many specimens. JASPER COUNTY: Falmouth, July 26, 1954, English, Stannard, on soybeans with spider mites, 11 ♀, many immatures; Newton, July 26, 1954, English, Stannard, on soybean plant with spider mites, 1 ♀. LAWRENCE COUNTY: Lawrenceville, August 7, 1953, Smith, Moore, Stannard, in prairie, 1 ♀. RANDOLPH COUNTY: Walsh, September 18, 1966, Meyer, on apple trees feeding on spider mites, many specimens.

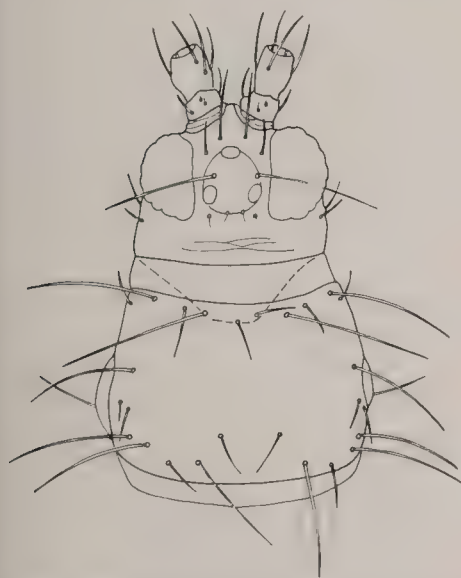


Fig. 127.—*Scolothrips pallidus*, head and prothorax.

Sericothrips Haliday

Sericothrips Haliday (1836:444). Type-species by monotypy.—*Sericothrips staphylinus* Haliday. (The name *staphylinus* corrected to *staphylinus* by Burmeister, 1838).

Rhytidothrips Karny (1910:49). Type-species by monotypy.—*Rhytidothrips bicornis* Karny. Synonymized by Priesner (1926b).

(?) *Hydatothrips* Karny (1913:281). Type-species by monotypy.—*Hydatothrips adolfi-friderici* Karny. (Name should be corrected to *adolphi-friedrichi*.) Questionably synonymized by Priesner (1949).

Head wider than long, not at all prolonged in front of eyes. Ocelli on slightly raised area. Interocellar setae relatively short. Antennae eight segmented, segments III and IV each with a forked sense cone, segment VI with or without a small pedicel. Mouth

cone pointed. Maxillary palps three segmented.

Prothorax with one pair of posterior setae moderately developed. All other setae relatively small. Pronotum sculptured with hexagonally reticulate lines or transverse striae, median part of pronotum (blotch) usually with closer spaced striae and often with dark markings. Meso- and metascutum sculptured. Mesospinasternum separated from metasternum by suture. Fore wings narrow with two longitudinal veins; fore vein evenly set with setae, hind vein with several or one or no setae at apex; fringe cilia wavy. Tarsi two segmented.

Abdominal segments I-VIII covered with microsetae except a median area which is often bare. Abdominal sternites II-VI with major setae along posterior margin, sternite VII with major setae much forward of posterior margin. Abdominal sternites without accessory setae except for microsetae, abdominal tergites with median setae closely spaced. Abdominal tergites VII and VIII and sometimes VI with a complete comb of posteriormarginal setae. Females with well-developed ovipositor. Males either with small, circular abdominal glandular areas, one each on sternites IV-VII, V-VII, or VII only, or glandular areas entirely absent. Males without thornlike setae on abdominal tergite IX.

This genus is similar to *Scirtothrips*. The differences between these genera and other genera in Illinois whose species bear many microsetae on the abdomen are discussed under *Scirtothrips*. In brief, *Sericothrips* can be distinguished from these genera by the characteristics of the eight-segmented antennae and/or the possession of a uniform row of setae on the fore vein of the fore wing.

Apparently the members of this genus are entirely leaf feeders. Some of them are closely associated with specific hosts, limited to one or two plant species. The habits of a few are unknown, and several common species may be taken on many hosts. The species seem to have unusual jumping powers and even the larvae are quick and active. Most, if not all, overwinter

in the adult stage in grass clumps, under fallen leaves, under bark, or in hollow plant stems.

Thirteen species occur in Illinois and all but two are present throughout the state. Those two, *pedicellatus* and *smithi*, are limited to the southern half of the state. None of them have been reported to cause damage of economic consequence in Illinois, although *Sericothrips variabilis* is often abundant on soybeans and alfalfa.

A key to the known species of *Sericothrips* of the world was presented by Hartwig (1952). Supplementary couplets were given by Faure (1958) to bring the Hartwig key up to date.

KEY TO SPECIES

(ILLINOIS, EXCEPT WHERE NOTED)

1. Brachypterous 2
Macropterous 3
2. Abdominal segments II, III, and VII dark brown *smithi*
Abdominal segments I-III, and VII-X dark brown *cingulatus*
3. Prothorax entirely dark brown or black 4
Prothorax in part, or entirely, pale yellow or white 6
4. Abdominal tergites closely and entirely covered by microsetae *cingulatus*
Abdominal tergites devoid of microsetae on median portions of the intermediate segments 5
5. Prothoracic sculpture closely and finely transversely striate; abdominal tergite VII with posterior setal comb interrupted in the middle; on water lily pads *langei*
Prothoracic sculpture coarse, nearly hexagonally reticulate beyond the blotch; abdominal tergite VII with a complete posterior setal comb; on leaves of *Ptelea* *pulchellus*
6. Antennal segment VI pedicellate 7
Antennal segment VI not pedicellate, broadly joined to segment V; males with glandular area absent or on abdominal sternite VII only 8
7. Intermediate abdominal tergites with lateral brown spots, no tergite completely and abruptly brown *pedicellatus*
Intermediate abdominal tergites lacking lateral brown spots, tergites II, III, and VII completely and abruptly brown *desmodianus*
8. Abdomen entirely pale yellow to white in coloration 9
Several to many abdominal segments darkly colored with shades of brown; or dorsum of intermediate abdominal segments with a dark transverse line across the basal region, occasionally this band pale in the middle and not complete; or with at least lateral

- patches of brown on abdominal segment II.....10
9. Wings dark; on various plants.....*nubilipennis*
Wings pale; on *Tilia* (linden).....*tiliae*
10. Sculpture of pronotum widely separated in front of blotch (Fig. 128), subhexagonally reticulate rather than transversely striate.....11
Sculpture of pronotum occasionally slightly more widely separated in front of blotch but always more or less transversely striate.....12
11. Wings bicolored, white and gray-brown banded.....*annulipes*
Wings nearly uniformly dark gray; not yet found in Illinois.....*fraxinicola*
12. Pronotum pale without any definite brown markings, at most with a faint cloud of brown at the anterior margin of the blotch.....*sambuci*
Pronotum with brown markings within the blotch, or blotch entirely brown.....13
13. Pronotal blotch uniformly and completely brown; only slightly and evenly incised along the posterior margin.....*baptisiae*
Pronotal blotch with brown coloration, irregularly outlined or brown only in patches; if predominantly brown, posterior margin deeply incised by yellow.....14
14. Abdominal segment VII completely brown in sharp contrast to segment VI.....*variabilis*
No abdominal segment completely dark in color in sharp contrast to the other segments.....15
15. Fore wing with two additional setae at the apex behind the principal longitudinal vein; on hops.....*beachae*
Fore wing with only one or none of these additional setae.....16
16. Fore wing without setae behind the principal veins; on nettle; not yet found in Illinois.....*apicalis*
Fore wing with one seta behind the principal vein.....17
17. Antennal segment III gray.....*interruptus*
Antennal segment III light yellow at base.....18
18. Posterior setae of prothorax moderately long; on wild four-o'clock flowers.....*campestris*
Posterior setae of prothorax shorter; not yet found in Illinois.....*zebrae*

Sericothrips annulipes Hood

Sericothrips annulipes Hood (1927c: 211). ♀, ♂. Type-locality.—Ithaca, New York.

FEMALE (macropterous).—Length distended about 1.1 mm. Colored predominantly pale yellow with numerous brown markings. Brown: antennal segment III at apex, antennal segment IV in apical half, all of antennal seg-

ments V–VIII, ocellar area, median of the occiput, spots in the pronotal blotch, anterior half of the mesoscutum, most of the metascutum, sides of abdominal segment I, most of abdominal segment II, the anterior line and sides of abdominal segments III–VI, and all of abdominal segments VII and VIII. Fore wings with two dark crossbands neither of which is as sharply defined as in *variabilis*. Legs with spots of grayish brown on each of the segments except the tarsi.

Antennal segment VI not pedicellate. Anterior part of pronotum with widely spaced, nearly subreticulate, sculpture (Fig. 128). Median portion of intermediate abdominal tergites generally lacking microsetae. Posterior comb of setae complete on abdominal tergites VII and VIII, although comb on tergite VII sometimes weak in the middle.

MALE (macropterous).—Length distended about 1 mm. Similar to female in general structure and color patterns except slightly lighter in color. Usually abdominal segment VII pale yellow rather than abruptly brown. Abdominal sternite VII with a small, circular, median glandular area.

This species can be distinguished by the combination of the following characteristics: widely spaced, nearly subreticulate sculpture on the anterior portion of the prothorax; nonpedicellate sixth antennal segment; light colored thorax; and abrupt dark color of abdominal segment VII.

In general color and structure *annulipes* resembles *pedicellatus*. The two differ in the extent of brown coloration.

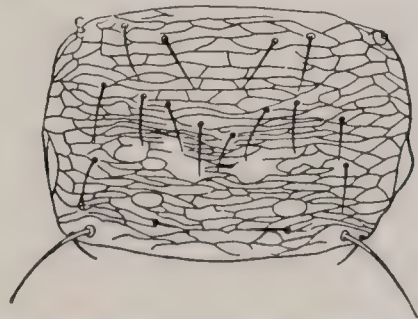


Fig. 128. Prothorax of *Sericothrips annulipes*. From Hood (1927c).

tion on the abdomen and in the form of antennal segment VI.

Often *annulipes* is found on leaves of locust trees, apparently its principal host. It is common throughout the state and probably is even more common than originally, owing to the extensive cultivation of locust trees, especially black locust, by European man in recent years.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, BOND, CHRISTIAN, CLAY, CLINTON, COLES, DE WITT, FULTON, GREENE, HARDIN, HENDERSON, JERSEY, JOHNSON, LA SALLE, MACOUPIN, MARSHALL, MASON, MERCER, MORGAN, PERRY, PIATT, PIKE, PULASKI, PUTNAM, SANGAMON, ST. CLAIR, STEPHENSON, UNION, VERMILION, and WINNEBAGO.

***Sericothrips baptisiae* Hood**

Sericothrips baptisiae Hood (1916d: 113). ♀, ♂. Type-locality.—Mount Vernon, Virginia.

FEMALE (macropterous).—Length distended about 1.2 mm. Bicolored brown and yellow. Brown: head, pronotal blotch, most of meso- and metathorax, abdominal segments I–III and VII–X, apical half of antennal segments IV and V and all of segments VI–VIII, coxae and mid portions of femora, two crossbands and extreme basal region of fore wing. Remainder of body and appendages yellow except sides of abdominal segments IV–VI which have light brown spots.

Pronotal striations in front of blotch fairly widely spaced, more transverse than reticulate. Median dorsal portions of intermediate abdominal segments generally lacking microsetae. Posterior setae combs present on abdominal segments VII and VIII but weak on the median of segment VII.

MALE (macropterous).—Length distended about 1 mm. Similar to female except abdominal segment X much lighter in color, nearly yellowish. Sternal glandular areas lacking on the abdomen.

In disagreement with Hood (1916d) *baptisiae* is seemingly more closely re-

lated to *variabilis* than to *cingulatus*. In my opinion *cingulatus* is one of the most distant relatives of *baptisiae* in North America. *Sericothrips baptisiae*, as does *variabilis*, belongs to that group of *Sericothrips* which lack microsetae over the entire dorsum of the abdomen, which lack a pedicel on antennal segment VI, which have two more or less distinct dark crossbands on the fore wings, and whose males lack abdominal sternal glandular areas. By contrast *cingulatus*, of the *staphylinus* complex (Stannard 1951), has the entire dorsum of the abdomen covered by microsetae, has a pedicel on antennal segment VI in macropterous forms at least, does not have two dark crossbands on the fore wings, and also differs in that its males have three abdominal sternal glandular areas.

Sericothrips baptisiae is darker in the body and lighter in its fore wing coloration than *variabilis*. The most noticeable distinguishing feature of the two species is in the extent of color of the pronotal blotch. In *baptisiae* this blotch is slightly incised by yellow posteriorly, whereas in *variabilis* the yellow color protrudes deeply into the blotch in the form of an upturned, solid U.

This species feeds, probably exclusively, on the leaves of false indigo (*Baptisia*). It occurs throughout the state wherever its host is found.

Illinois records.—Collected during summer and autumn until the middle of October, from one to several localities in the following counties: ADAMS, BOND, CARROLL, CLARK, COOK, GRUNDY, HARDIN, JASPER, JEFFERSON, JOHNSON, KANKAKEE, KNOX, MARION, McDONOUGH, PIATT, VERMILION, and WAYNE.

***Sericothrips beachae* Hood**

Sericothrips beachae Hood (1927a:133). ♀. Type-locality.—White Heath, Illinois.

FEMALE (macropterous).—Length distended about 1.2 mm. General color yellow with some gray and grayish brown markings. Grayish brown: antennal segment II at the sides, apical

half of segments III-V, and all of segments VI-VIII; several spots, more or less contiguous, on the pronotal blotch, being less extensive than in *campestris*; spots on the meso- and metanotum; spots on the sides of abdominal tergites I-VII; and the anterior margin of abdominal segments II-VII. Fore wings generally pale gray—lighter just beyond scale, in the middle, and at the tip, making each wing appear to have two faint crossbands.

Pronotum transversely striate but with fewer straight lines of sculpture than in *campestris*. Fore wings, in almost all cases, with two additional setae at the apex behind the longitudinal vein. Median portions of most of the abdominal segments on the dorsum more or less without microsetae. Abdominal tergites VII and VIII, as well as tergite VI usually, with posterior setal combs complete.

MALE (macropterous).—Length distended about 1 mm. Similar to female in general color and structure. Abdominal setal combs same as in female. Abdominal sternite VII with a small, circular, median glandular area.

This member of *Sericothrips* is a poorly understood species. It has been seldom collected in the past and even now it is known only from the Midwest on hops.

Because this species is seemingly confined to hops, and because it does not occur in Europe (I have personally made several attempts to collect it in England and Austria), it is reasonable to suppose that our hop vines in the Midwest also are a native rather than introduced species. Dr. E. L. Davis, formerly of the St. Louis Botanical Gardens, wrote me in 1956 that the midwestern hop appeared to be of a slightly different type than the European form. Until more is known, the host of *Sericothrips beachae* should be listed as the midwestern hop, whose scientific name and botanical status are still controversial.

In Illinois, *beachae* most closely resembles *campestris* and in some ways *interruptus*. From these two species *beachae* may be distinguished by having on each fore wing two apical setae on the hind vein. Both *campestris* and

interruptus have only one seta or, rarely, none in this area of the fore wing. Males of *beachae* have a complete posterior setal comb on abdominal segment VII, whereas males of *campestris* and *interruptus* have the setal comb on segment VII interrupted medially.

Before the wide use of weed killers, *beachae* could be found on the numerous hop vines growing on roadside fences. Now the hop plant and its thrips have become scarce in many areas, often being limited to uncultivated places in bottomlands.

Illinois records.—Collected in spring and summer, from one to several localities in the following counties: ADAMS, BOONE, CARROLL, CHAMPAIGN, CLARK, EDGAR, FULTON, GREENE, HANCOCK, HENDERSON, KNOX, LA SALLE, LIVINGSTON, LEE, LOGAN, MARSHALL, MCLEAN, PIATT, PIKE, PUTNAM, ROCK ISLAND, SANGAMON, STARK, TAZEWEEL, VERMILION, and WINNEBAGO.

Sericothrips campestris Hood

Sericothrips campestris Hood (1939a: 556). ♀. Type-locality.—Palacios, Texas.

FEMALE (macropterous).—Length distended about 1.1 mm. Color in life, gray to the naked eye. Color when mounted in Hoyer's medium, predominantly light yellow with numerous gray-brown markings. Antennal segment II, apex of segment III, apical half of segments IV and V, and all of segments VI-VIII gray-brown. Gray-brown to gray: ocellar triangle, usually base of head, several contiguous spots covering much of the pronotal blotch, spots on the meso- and metanotum, lateral spots on abdominal tergites I-VIII, anterior margins of abdominal tergites II-VII, and edges of the coxae, especially the fore coxae. Fore wings with gray at the base above the scale, a gray spot again a short distance beyond the scale, and a faint gray cloud on the outer third of the wing but not extended to the tip.

Pronotum sculptured similarly to *beachae* except slightly more evenly

transverse. Fore wing with only one (rarely none, never two) seta just behind longitudinal vein near tip. Posterior setal combs complete on abdominal segments VII and VIII, never complete on segment VI.

MALE (macropterous).—Length distended about 0.9 mm. Similar to female in general color and structure. Posterior setal comb complete only on abdominal segment VIII (not complete on segments VI and VII). Abdominal sternite VII with a faint, median, circular, glandular area.

What I believe to be *campestris*, or at least a form of it, is commonly found in Illinois on wild four-o'clock (*Mirabilis nyctaginea*). This thrips is often abundant on the leaves and flowers of its host plant. In winter, *campestris* may be found hibernating in the dried hollow stems of this plant.

Our Illinois form appears to be lighter in color than the Texas holotype, according to the protolog, and is even lighter in color than Missouri specimens. For example, the northern populations have only faint evidence of wing bands in contrast to the Texas specimens, which, according to Hood's description, have distinctly marked crossbands.

In relationship, *campestris* is close to *beachae*. When compared alive, these two species are easily distinguished. To the naked eye *beachae* appears to be yellowish gray whereas *campestris* appears to be darker gray. Also these two species are easily distinguished by hosts—*beachae* prefers hops whereas *campestris* prefers wild four-o'clocks. Structurally the two differ but slightly. *S. campestris* almost always bears but one seta at the wing tip behind the principal longitudinal vein. *S. beachae*, except in rare cases, bears two setae behind the longitudinal vein.

The species *zebrae*, which seemingly prefers *Clematis*, is also similar to *campestris*. The two differ in pronotal setation. So far *zebrae* has been found only in the northeastern states (not in Illinois).

Sericothrips apicalis is also similar to light forms of *campestris*. Because I strongly suspect that the name *api-*

calis applies to a variant of *campestris* which lacks additional fore wing setae, *apicalis* is omitted from the Illinois report as an entity with full species rank in our fauna.

One other species, *Sericothrips interruptus*, might be confused with *campestris*. Both have but one additional seta behind the longitudinal vein and they are similar in general color. They differ in exact color, especially in the antennae, and slightly in the pronotal sculpture.

Wild four-o'clock and its thrips *S. campestris*, may or may not be native to Illinois. Opinions to the contrary notwithstanding, it seems a possibility that wild four-o'clock and *campestris* did originally occur in Illinois at least in the sand areas. Since then they have spread out along gravelly railroad embankments.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, BOND, CHAMPAIGN, CHRISTIAN, CLARK, DE WITT, EFFINGHAM, FORD, FULTON, HANCOCK, HENDERSON, IROQUOIS, JACKSON, JO DAVIESS, KNOX, LEE, LIVINGSTON, LOGAN, MACON, MCHENRY, MCLEAN, MARSHALL, MASON, MORGAN, PEORIA, PERRY, PIATT, PIKE, PUTNAM, ROCK ISLAND, STEPHENSON, WINNEBAGO, and WOODFORD.

Sericothrips cingulatus Hinds

Sericothrips cingulatus Hinds (1902: 141). ♀, ♂. Type-locality.—Amherst, Massachusetts.

FEMALE (macropterous).—Length distended about 1.2 mm. Bicolored brown and yellowish. Dark brown: head, most of thorax, abdominal segments I–III and VII–X. Yellowish: most of abdominal segments IV–VI. These middle abdominal segments become brownish on the meson with segment VI being the darkest. Antennal segments I and II yellowish, segment III yellowish brown, segments IV–VIII brown. Coxae, trochanters, and most of femora brown, rest of legs yellow. Extreme base and apical three-fourths of the fore wing brown, basal one-fourth nearly colorless.

Antennal segment VI pedicellate.

Pronotum with fairly close, transverse striations. Most of the abdominal tergites completely and uniformly covered with microsetae. Posterior setal combs complete on segments I–VIII.

FEMALE (brachypterous).—Similar to macropterous form except smaller (about 1 mm) and pedicel of antennal segment VI poorly differentiated, nearly absent.

MALE (brachypterous).—Length distended more than 0.9 mm. Similar in general structure and color to brachypterous female. Abdominal sternites I–VII each with a transverse glandular area. These glands become progressively more elongate posteriad.

Although discovered more than 50 years ago and repeatedly collected since then, the life history and habits of this species still remain virtually unknown. Usually individuals are found in grasslands, especially in grass-sedge marshes. Some, at least, overwinter in clumps of prairie grasses.

Hinds' original material consisted of brachypterous forms. Later, in 1911, Moulton collected fully winged specimens from Nebraska. In Illinois we have taken brachypterous males and females and macropterous females. This species was first reported from Illinois by Hood (1917) and we have found many other specimens. Our records indicate that *cingulatus* has a statewide distribution.

In all forms, whether fully winged or short winged, *Sericothrips cingulatus* has the dorsum of the abdomen completely covered by microsetae. Only one other Illinois congener has the abdomen similarly clothed and that one, *S. smithi*, is always short winged, as far as is known, and is differently colored. *Sericothrips smithi* has abdominal segments II, III, and VII brown whereas *cingulatus* has abdominal segments I–III and VII–X brown.

Illinois records.—Collected from May to October, from one to several localities in the following counties: ADAMS, CLARK, FRANKLIN, JACKSON (USNM), JOHNSON, KNOX, MARION (USNM), MASON (USNM), MORGAN, PIKE, PULASKI (USNM), SANGAMON, and UNION (USNM).

***Sericothrips desmodianus* new species**

FEMALE (macropterous).—Length distended slightly more than 1 mm. General color yellowish with brown markings. Brown: head in region of ocelli, much of the pterothorax, abdominal segments II, III, and VII abruptly, abdominal segment I at sides, a thin median line along the anterior margins of abdominal segments IV–VI, and all coxae. Fore wings with a dark gray subbasal crossband. Antennal segment I yellowish, II grayish, III paler than II, IV and V yellowish at base, brown at apex, segments VI–VIII brown. Last three abdominal segments brighter yellow.

Antennal segment VI pedicellate. Mouth cone long. Pronotal striae fairly wide apart, transverse striae becoming nearly subreticulate. Median portion of intermediate abdominal tergites for the most part lacking microsetae. Abdominal tergites VII and VIII with posterior setae combs complete.

MALE (macropterous).—Similar to female except abdomen lighter in color. Abdominal sternites IV–VII each with a small, circular, median glandular area.

Holotype.—Female, Siloam Springs State Park, Adams County, Illinois, August 11, 1948, Sanderson, Stannard, on *Desmodium paniculatum*. **Allotype.**—Male, Harrisburg, Saline County, Illinois, June 23, 1950, M. W. Sanderson, Hilltop prairie. **Paratypes.**—6 ♀, Lawrenceville, Lawrence County, Illinois, August 7, 1953, Smith, Moore, Stannard, *Andropogon* prairie. 4 ♀, Bell Smith Springs Recreation Area, Pope County, Illinois, July 16, 1947, L. J. Stannard, on *Lespedeza*. 1 ♀, Closter, New Jersey, July 9, 1938, J. C. Crawford, on *Desmodium*. 1 ♂, Tenaflly, New Jersey, June 18, 1939, J. C. Crawford, on *Desmodium*.

Types deposited in the Illinois Natural History Survey and in the U.S. National Museum.

This species may be distinguished by the combination of the pedicellate form of antennal segment VI, the lack of microsetae on the central portion of many of the abdominal tergites, and

the lack of lateral spots on the intermediate abdominal tergites. It can be distinguished from *pedicellatus*, in particular, by the abrupt brown color of abdominal tergites II, III, and VII.

The late J. C. Crawford once told me he suspected that this species was new, although similar to *pedicellatus*. Recent comparisons of specimens of *desmodianus* with the holotype *pedicellatus*, have convinced me that Mr. Crawford's assumption was correct.

Apparently *desmodianus* is a southern species. In Illinois its range is outside the Wisconsin drift area and extends west and north to Adams County and east to Lawrence County. It seems to prefer legumes, especially *Desmodium*.

Sericothrips interruptus Hood

Sericothrips interruptus Hood (1927a: 136). ♀, ♂. Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended about 1.1 mm. General color yellowish with some brown markings. Brown: the ocellar triangle, several more or less contiguous spots on the pronotal blotch, the anterior and lateral portions of the mesoscutum, two spots on the metanotum, the anterior margins of abdominal segments II–VII, and spots on the side of abdominal segments II–VII. Wings and antennae grayish brown. Often wing veins reddish. Ocellar rings red.

Pronotal striations transverse. Median areas of most of the abdominal segments generally without microsetae. Posterior combs of abdominal segments VII and VIII complete.

MALE (macropterous).—Length distended about 0.9 mm. Generally similar to female. Abdominal sternite VII with a small, circular, median glandular area which is sometimes faint.

The species closely resembles *beachae* and *campestris*. All three are light in color with gray-brown patches on the thorax and abdomen. The most noticeable difference between *interruptus* and the other two is the color of the antennae. In *interruptus* most

of the antennal segments are grayish brown whereas in *beachae* and in *campestris* the intermediate antennal segments are yellow in the basal halves and brown in the apical halves. *S. interruptus*, in certain mounting media and under certain conditions, exhibits red coloration along the veins of the fore wing. Individuals of *beachae* or *campestris* never show such red coloration.

Apparently the leaves of ash, *Dirca*, and some other forest trees and shrubs are the preferred hosts of *interruptus*. Many specimens of this species have been collected from the major regions of Illinois.

A species described by Hood (1940c) as *S. fraxinicola* was taken on ash (*Fraxinus americana*) in Oswegatchie, New York. This species could not be confused with *interruptus*, which also occurs on ash, because of the form of the pronotal sculpture. In *interruptus* the sculpture is arranged as more or less parallel striae, whereas in *fraxinicola* the sculpture is subreticulate and coarser than illustrated by Hood (1927c) for *annulipes*.

Illinois records.—Collected from April through November, from one to several localities in the following counties: ADAMS, CHAMPAIGN, COLES, COOK, EDGAR, EFFINGHAM, HENDERSON, JACKSON, LA SALLE, LAWRENCE, MARION, MONROE, PUTNAM, RANDOLPH, VERMILION, and WILLIAMSON.

Sericothrips langei Moulton

Water Lily Thrips

Sericothrips langei Moulton (1929b: 230). ♀. Type-locality.—Fish Lake, Monroe County, Illinois.

FEMALE (macropterous).—Length distended slightly more than 1 mm. Body color brown to blackish brown, lighter in regions of the thorax. Antennal segment I, tip of segment V, and all of segments VI–VIII brown; other segments yellowish. Legs brown except apical half of tibiae and all of the tarsi yellowish. Fore wings with two dark crossbands, base of wings without additional brown streak.

Pronotum throughout with closely spaced transverse striae. Midregion of

the abdominal tergites, for the most part, without microsetae. Posterior setal combs complete only on abdominal segment VIII.

MALE (macropterous).—Length distended nearly 0.9 mm. General structure and color as in female. Abdominal sternite VII with a small, round, central glandular area.

The water lily thrips, *S. langei*, is similar in coloration to *pulchellus*; however, in the former species the brown color extends slightly farther on the antennae and legs. The two species are easily recognized by several features. *S. langei* is closely transversely striate on the anterior part of the pronotum, it lacks a complete posterior setal comb on abdominal tergite VII, and the base of the fore wing is colorless. By contrast *S. pulchellus* has widely spaced striae on the anterior part of the pronotum, has a complete posterior setal comb on abdominal tergite VII, and the base of the fore wing is brown.

Nearby oil wells have so contaminated the waters at the type locality in recent years that possibly the originally known population has been extirpated. Nevertheless, a few miles to the south near Burkesville many other populations can be found in the numerous sinkhole lakes. This species occurs solely on the leaves of *Nymphaea* water lilies and often is locally abundant. Our records indicate that the species is found as far north as Au Train, Michigan.

In 1937 Watson described another form, *Sericothrips langei* var. *tissoti*, from water lilies taken at Lochloosa Lake, Florida. This entity, although similar to *langei* from Illinois, differs decidedly in that each fore wing has only one dark band instead of two. Possibly *tissoti* deserves to be elevated to full specific rank.

Another similarly formed species seems to be *andrei*, a species which does not occur in Illinois or, at least, has not been found here as yet. These two differ from each other by the several characteristics enumerated by Crawford in 1943, page 41.

Illinois records.—CUMBERLAND COUNTY: Woodbury, June 29, 1949,

Smith, Stannard, leaf of *Nymphaea*, 1 ♀. JEFFERSON COUNTY: Bonnie, May 24, 1955, Kaiser, Stannard, leaf of *Nymphaea*, 1 ♀. LAKE COUNTY: Zion (Beach State Park), August 30, 1955, Moore, Stannard, leaves of *Nymphaea*, 5 larvae. MONROE COUNTY: Burkesville, June 29, 1949, Smith, Stannard, leaves of *Nymphaea*, 29 ♀, 3 ♂; Fish Lake (type locality), August 30, 1921, Lange, sweeping, 3 ♀. WILLIAMSON COUNTY: Crab Orchard Lake, May 25, 1954, Smith, Moore, Stannard, leaves of *Nymphaea*, 2 ♀.

Sericothrips nubilipennis Hood

Sericothrips nubilipennis Hood (1924: 312). ♀. Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended about 1.1 mm. General color pale yellow with the following areas brown: ocellar area, antennal segment II at side, antennal segments IV and V at tips, all of antennal segments VI–VIII, spots on the prothorax, mesothorax, and metathorax, scale of fore wing and part of the area above it, and most of the rest of the fore wing except the tip and area just beyond scale. Abdomen entirely pale yellow to white without any markings.

Pronotum closely, transversely striate. Midregion of the abdominal tergites, for the most part, without microsetae. Posterior setal combs complete on abdominal segments VII and VIII.

MALE (macropterous).—Length distended about 0.8 mm. Similar to female in general color and structure. No abdominal glandular areas discernible.

Although frequently observed on the leaves of many forest trees, this species eventually may be found to have one or several preferred hosts. One host may be hackberry, another may be dogwood. Larvae in association with adults were taken once from hackberry leaves at Oquawka, Illinois. Adults overwinter in woodland leaf mold.

Sericothrips nubilipennis can be distinguished from all of its Illinois congeners by the completely pale ab-

domen and by the predominantly dark brown wings. It occurs throughout the state.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, CHAMPAIGN, CLARK, COLES, COOK, EFFINGHAM, HARDIN, HENDERSON, KANE, KNOX, LA SALLE, LOGAN, MARSHALL, MASON, OGLE, PERRY, PIATT, POPE, PUTNAM, RICHLAND, and VERMILION.

***Sericothrips pedicellatus* Hood**

Sericothrips pedicellatus Hood (1927a: 131). ♀. Type-locality.—Makanda, Illinois.

FEMALE (macropterous).—Length distended about 1 mm. General color yellow with brown markings. Brown: head between ocelli, several pairs of spots within blotch of pronotum, anterior margin of mesoscutum, metascutum, patches along side of pterothorax, all coxae, median outer spot on all femora, sides of abdominal tergite I, anterior half of abdominal tergite II, and entire anterior margin and sides of abdominal tergites III–VII becoming greater in extent posteriorly with tergite VII darkest, nearly as dark as II. Antennal segments I–III white to pale yellow, IV yellow in basal one-fourth with remainder brown, V brown except for yellow pedicel, VI–VIII brown. Fore wings with a light gray band subbasally.

Antennal segment VI pedicellate. Mouth cone long. Pronotal striae moderately far apart, transversely striate to nearly subreticulate. Median portion of intermediate abdominal tergites seemingly lacking microsetae. Abdominal tergites VII and VIII with posterior setae combs complete.

MALE. Unknown.

This species is based solely on the holotype.

From its Illinois congeners which also have antennal segment VI pedicellate, the color of the abdominal segments will serve to distinguish it. Unlike *cingulatus* and *desmodianus*, *pedicellatus* does not have any anterior or posterior abdominal segments abruptly dark brown. In *pedicellatus*

no tergite is entirely brown as is the case in *smithi*. In addition, *pedicellatus* is unlike *desmodianus* in that the anterior marginal brown strip on the abdominal segments is expanded at the sides into distinct spots.

Despite repeated efforts specimens other than the holotype have not been collected, not even at the type locality.

Illinois record.—JACKSON COUNTY: Makanda, June 26, 1909, Hart, sweeping grass and weeds, 1 ♀.

***Sericothrips pulchellus* Hood**

Sericothrips pulchellus Hood (1908c: 363). ♀, ♂. Type-locality.—Muncie, Illinois.

FEMALE (macropterous) (Fig. 129).—Length distended about 1 mm. Body color brown to blackish brown, lighter in regions of the thorax, and center and tip of abdomen. Antennae mostly yellow; segments I and II, apical half of VI, and all of VII and VIII brown. Coxae to femora brown, rest of legs yellow except mid and hind tibiae which are brown to blackish in the subbasal area. Fore wings with two dark crossbands in addition to the dark spot at the base and on the scale. Most of body with red subintegumental pigment.

Pronotum with widely spaced striations anterior to the blotch. Mid-region of the abdominal tergites, for the most part, without microsetae. Posterior setal combs complete on abdominal segments VII and VIII and sometimes on segment VI.

MALE (macropterous).—Length distended about 0.8 mm. General structure and color as in female. Abdominal sternite VII with a small, round, central glandular area.

This species and *S. langei* are the darkest colored *Sericothrips* in Illinois. Both are almost entirely dark brown, exclusive of the appendages. They may be easily distinguished from each other by the form of the striations on the pronotum—*pulchellus* has widely spaced, nearly hexagonal reticulations on the anterior part of the pronotum, whereas *langei* has closely spaced, transverse striations over the pronotum.



Fig. 129.—*Sericothrips pulchellus*, dorsal aspect.

During spring and summer *pulchellus* feeds on leaves of wafer ash (*Ptelea*), sometimes in great numbers. Adults and larvae feed together, often causing the foliage to become whitened by their feeding scars. At times of greatest abundance adults may scatter and be found resting on a variety of trees and shrubs. In early fall these thrips begin to leave their host plant and settle in debris on the forest floor where they hibernate.

Sericothrips pulchellus occurs in our state wherever wafer ash grows (Winterringer & Evers 1960).

Illinois records.—Collected from April through September, from one to several localities in the following counties: ADAMS, CALHOUN, CARROLL,

CHAMPAIGN, COOK, GRUNDY, HANCOCK, KANKAKEE, LA SALLE, LIVINGSTON, MACOUPIN, MADISON, MASON, OGLE, PEORIA, PIKE, PUTNAM, ROCK ISLAND, VERMILION, WAYNE, WHITESIDE, and WINNEBAGO.

Sericothrips sambuci Hood

Sericothrips sambuci Hood (1924:313). ♀. Type-locality.—Bladensburg, Maryland.

Sericothrips walteri Crawford, J. C. (1938:36). ♀, ♂. Type-locality.—Washington, D. C. New synonymy.

FEMALE (macropterous).—Length distended about 1.4 mm. General color pale whitish yellow. Antennal seg-

ments pale yellow except tip of segment III, apexes of IV and V, and all of VI–VIII, which are brown. Fore wing with a brown cloud at base of scale and with a brown, subbasal, incomplete crossband located predominantly on the trailing half of the wing. Mesothorax and metathorax each with a pair of brown spots. Abdominal segments II–VII each with a pair of lateral brown spots, the spots on segment II being the darkest and largest.

Pronotum throughout closely transversely striate. Midregion of the abdominal tergites, for the most part, without microsetae. Posterior setal combs complete on abdominal segments VII and VIII.

MALE (macropterous).—Length distended about 0.8 mm. Similar to female in general structure and color, but somewhat lighter in color. Brown spots on at least abdominal segment II present. No abdominal glandular areas could be distinguished on the limited specimens available to me.

This common light-colored species feeds exclusively on elderberry leaves. In winter it hibernates under the loose bark of the host plant. It may be distinguished from other species of Illinois *Sericothrips* by the pale, nearly colorless pronotum and by the several brown spots on the abdomen, a pair of which are always present even though sometimes faint, on the sides of segment II.

Sericothrips sambuci is statewide in its distribution.

Illinois records.—Collected during the summer and early fall, from one to several localities in the following counties: ADAMS, BUREAU, CALHOUN, CARROLL, CHAMPAIGN, CHRISTIAN, CLARK, COOK, FRANKLIN, JASPER, KANE, KANKAKEE, KENDALL, LAKE, LIVINGSTON, MACOUPIN, MCHENRY, MERCER, MONTGOMERY, OGLE, PERRY, PIKE, SCHUYLER, UNION, VERMILION, WARREN, and WHITESIDE.

Sericothrips smithi Stannard

Sericothrips smithi Stannard (1951: 129). ♀. Type-locality.—Greenup, Illinois.

FEMALE (brachypterous).—Length

distended, exclusive of antennae, about 0.9 mm. Similar to *desmodianus* in color.

Antennal segment VI pedicellate. Mouth cone long. Pronotal striations widely spaced but more transverse than striate. Abdominal segments I–VIII densely and evenly covered by microsetae. Posterior setal combs complete on abdominal segments I–VIII.

MALE.—Unknown.

For the present this species is considered herein to be distinct from *desmodianus*. It is possible, however, that *smithi* may be only the brachypterous form of *desmodianus*, a fully winged species. Their separation is maintained because *desmodianus* lacks microsetae on parts of the median portions of the intermediate abdominal segments, whereas *smithi* bears microsetae over the entire dorsum of the abdomen. Since such differences in setal pattern do not occur in the winged and wingless stages of *cingulatus* (both are densely covered by microsetae on the abdomen), it is reasonable to suppose that *smithi* and *desmodianus* could be full species, even though closely related.

Besides the type-locality, *smithi* has been taken once in North Carolina and once in South Carolina (INHS records). In all cases the specimens came from grassland habitats.

Illinois record.—CUMBERLAND COUNTY: Greenup, March 5, 1949, Smith, ground cover, 6 ♀.

Sericothrips tiliae Hood

Sericothrips tiliae Hood (1931b:151). ♀, ♂. Type-locality.—Morton, New York.

FEMALE (macropterous).—Length distended about 1.3 mm. General color white. Apex of antennal segment IV, apical half of segment V, and all of VI–VIII brown. Ocellar rings reddish to orange.

Pronotum closely and transversely striate. Mid portions of the dorsum of the intermediate abdominal segments generally without microsetae. Posterior setal combs complete on abdominal segments VII and VIII.

MALE (macropterous).—Length

distended about 0.9 mm. Similar to female in general color and structure. Abdominal sternites apparently without glandular areas.

This is the lightest colored species of *Sericothrips* in Illinois. It is entirely white except for the apical segments of the antennae. Since these insects are so pale, they are best collected on the leaves of linden, their host plant, where they show up to advantage against the green background.

Sericothrips tiliae occurs throughout the state, being most common in the northern part.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, BOONE, CARROLL, CHAMPAIGN, COOK, DE WITT, EFFINGHAM, HANCOCK, HENDERSON, JACKSON, JO DAVIESS, KANKAKEE, LAKE, LA SALLE, LEE, LIVINGSTON, MARSHALL, MCLEAN, MERCER, PUTNAM, SCHUYLER, VERMILION, WARREN, and WHITESIDE.

Sericothrips variabilis (Beach)

Thrips variabilis Beach (1896:220). ♀, ♂. Type-locality.—Ames, Iowa. Lectotype fixed by Hood (1927a: 132). Transferred to *Sericothrips* by Hinds (1902).

FEMALE (macropterous).—Length distended about 1 mm. Bicolored brown and yellow. Brown: head; antennal segment III at apex, apical half of segments IV and V, and all of VI–VIII; pronotal blotch except for a deeply incised, median, posterior area; most of the anterior three-fourths of the pterothorax; abdominal segment I at the sides, all of segments II, III, VII, and VIII, and an anterior line on segments IV–VI. Abdominal segments IV–VI, IX, and X light brown in spots over a yellowish background. Fore wings dark in scale and small area immediately above it and with two dark, sharply defined crossbands. Coxae and femora with spots of brown of various degrees of intensity. Ocellar rings red.

Pronotum transversely striate. Median areas of intermediate abdominal segments generally without microse-

tae dorsally. Posterior setal combs complete on abdominal segments VII and VIII.

MALE (macropterous).—Length distended about 0.9 mm. Similar to female in general color and structure. Abdominal sternites seemingly without glandular areas.

Not only is this the first known species of *Sericothrips* in North America but also it has the distinction of being one of the most common in the eastern half of our country. Despite this early and continued knowledge of *variabilis*, its life history is unknown except for a few general details. It seems to prefer the leaves of herbs, particularly legumes, for food. It is abundant on soybeans but the extent of possible damage is unknown.

Sericothrips variabilis may be distinguished from its Illinois congeners by the following combination of characteristics: fore wings each with two sharply defined crossbands, pronotum dark only in the area of the blotch and this dark area deeply incised in the posterior median region by yellow, striations of the anterior portion of the pronotum not exceptionally widely spaced, and several of the abdominal segments abruptly dark brown.

This species occurs throughout Illinois.

Illinois records.—Collected during spring and summer, from one to several localities in the following counties: ADAMS, BUREAU, CALHOUN, CARROLL, CHAMPAIGN, CLAY, CLINTON, COLES, CUMBERLAND, DOUGLAS, EDGAR, EFFINGHAM, FAYETTE, FORD, GREENE, HENDERSON, IROQUOIS, JACKSON, JASPER, JEFFERSON, JERSEY, JO DAVIESS, JOHNSON, KANKAKEE, LAKE, LIVINGSTON, MACOUPIN, MADISON, MARION, MARSHALL, MASON, MCHENRY, MONROE, PIKE, POPE, PULASKI (Hood 1927a), RANDOLPH, ST. CLAIR, VERMILION, WABASH, WASHINGTON, WAYNE, WHITESIDE, and WILLIAMSON.

Taeniothrips Amyot and Serville

Taeniothrips Amyot and Serville (1843:644). Type-species by subsequent designation of Karny (1912b).

—*Thrips primulae* Haliday (= *picipes* Zetterstedt).

Head wider than long to as long as wide. Cheeks barely bulged to considerably bulged. Antennae eight segmented, abnormally seven segmented in North America but occasionally normally seven segmented elsewhere. Antennal segments III and IV with forked sense cones. Maxillary palps usually three segmented, labial palps two segmented.

Prothorax with only the two pairs of epimeral setae well developed. Mesospinasternum separated from metasternum by a suture. Fore legs not enlarged. All tarsi two segmented. Fore wings with two veins, setae on fore vein often interrupted, setae on hind vein uniformly spaced, fringe cilia wavy.

Abdomen with pleural plates. Tergites and sternites without microsetae. Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal sternites with or without accessory setae in addition to the posterior ones. Abdominal tergite VIII with or without posterior comb. Males with or without sternal glandular areas.

The type of the genus, a European species, has an elongated head and greatly bulged cheeks, and lacks accessory abdominal sternal setae. Species of *Taeniothrips* which most closely resemble the type-genus in the characteristic of the head occur indigenously in western North America rather than in the East. In none of our native Illinois species is the head particularly bulged.

Crawford (1941b) and Speyer (1951), by introducing the characteristic of the abdominal sternal setae in the definition of the species, helped the taxonomy of the genus over an enormous hurdle. Their discovery that some species have accessory setae on the abdominal sternites whereas others do not permits the easy separation or regrouping of many hard-to-identify species. Mr. Speyer has pointed out to me that this characteristic should be further investigated and analyzed in certain species in the genus *Thrips* to obtain a better understanding of this genus and *Taeniothrips* and their relationships.

As indicated, *Taeniothrips* is closely related to the genus *Thrips* and when all of the species of the world are considered, the two genera nearly grade into each other. In Illinois, members of *Taeniothrips* always can be recognized by the eight-segmented antennae. By contrast, Illinois specimens of *Thrips* always have seven segments in each antenna.

The taxon *Rhoplandrothrips* was erected by Priesner in 1922 as a subgenus of *Taeniothrips* for those species whose males have antennal segment VI enlarged and heavily setose. The European *ulmifoliorum* var. *obscurus* Uzel, later synonymized with *consociatus* Targioni-Tozzette by Priesner (1926b), was subsequently designated to be the inferred type-species by Priesner (1949). Because the western United States species, *Rhoplandrothrips corni* Moulton resembles *Taeniothrips albidus*, newly described here, the latter species may or may not prove to be another member of *Rho-*



Fig. 130-131.—Right antenna: 130, *Taeniothrips simplex*; 131, *Taeniothrips vulgatissimus*. From O'Neill & Bigelow (1964).

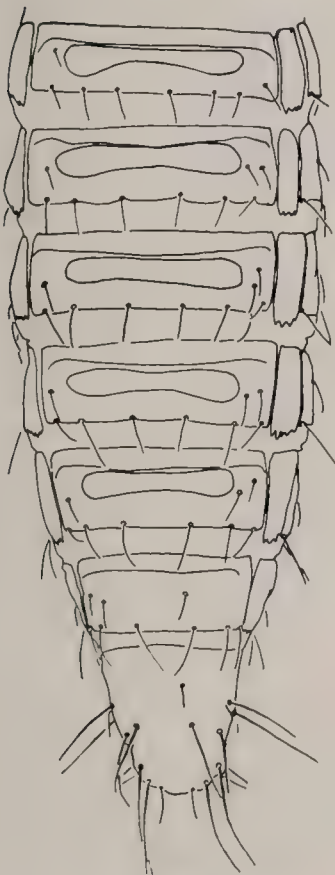
plandrothrips. Until the males of *albidus* are discovered there will not be the necessary evidence to include or exclude *Rhoplandrothrips* as a name applicable to the Illinois or eastern United States faunas.

O'Neill and Bigelow (1964) have treated the Canadian species.

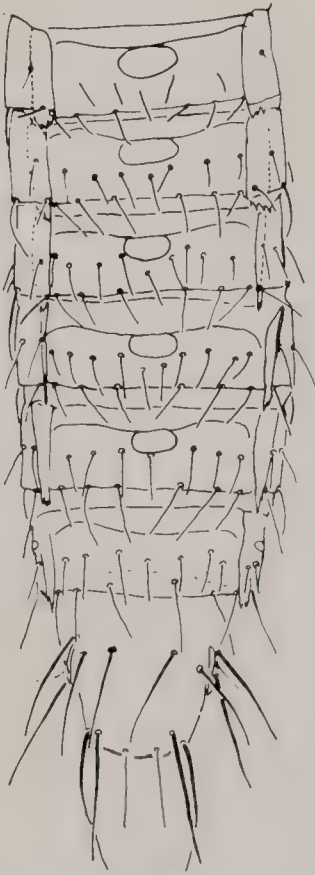
KEY TO SPECIES

- 1. Intermediate abdominal sternites with accessory setae in addition to posterior ones.....2
- Intermediate abdominal sternites without accessory setae in addition to posterior ones.....3
- 2. Distal half of the anterior vein of fore wing with five or more setae; antennal segment III moderately short (Fig. 130); male with abdominal sternal

- glandular areas strongly transversely elongate (Fig. 132); on *gladiolus*.....*simplex*
- Distal half of the anterior vein of fore wing with three setae; antennal segment III longer (Fig. 131); male with abdominal sternal glandular areas smaller, not as elongate (Fig. 133); abundant on *Heracleum vulgatissimus*
- 3. Abdominal tergite VIII with posterior comb incomplete to nearly absent.....*vaccinophilus*
- Abdominal tergite VIII with posterior comb complete (Fig. 134 and 135)....4
- 4. Fore tarsus with apical tooth.....4
- Fore tarsus without apical tooth.....5
- 5. Generally pale, nearly white in color; antennal segment II pale.....*inconsequens*
-*albidus* new species
- Bicolored brown and yellow or mostly brown; antennal segment III brown.....*betulae*



132



133

Fig. 132 133. Glandular areas on abdominal sternites, ♂: 132, *Taeniothrips simplex*; 133, *Taeniothrips vulgatissimus*. From O'Neill & Bigelow (1964).

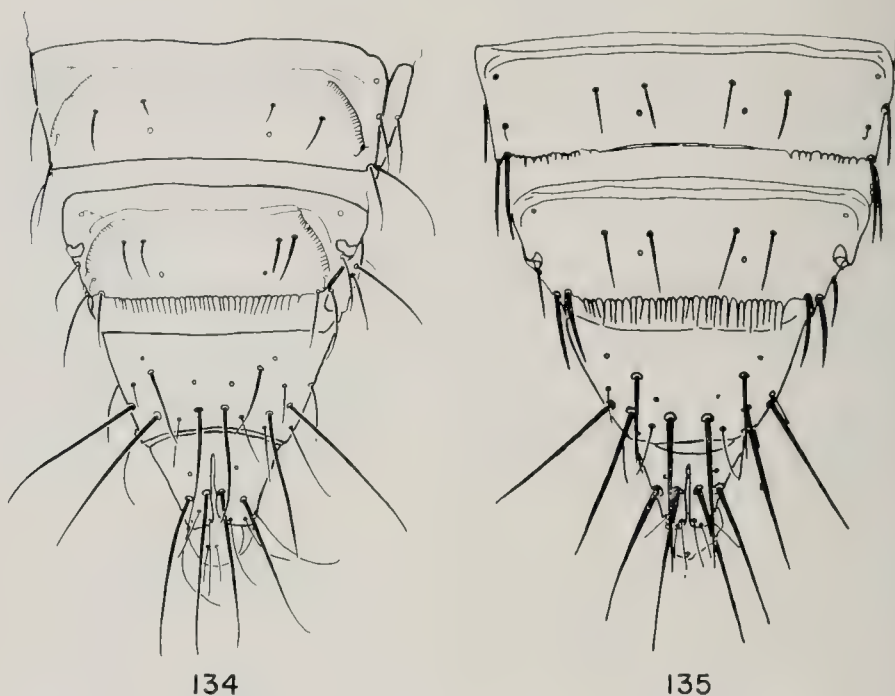


Fig. 134-135.—Abdominal terminalia, ♀: 134, *Taeniothrips vulgatissimus*; 135, *Taeniothrips betulae*. From O'Neill & Bigelow (1964).

***Taeniothrips albidus* new species**

FEMALE (macropterous).—Length distended over 1.2 mm. Color almost entirely dusky white. Brown: antennal segment IV at apex, most of segment V, and all of segments VI–VIII. Ocular pigments red.

Head not elongate or bulged. Interocular setae strongly developed. Antennal segment VI fairly broadly joined to segment V.

Prothorax with a few dorsal setae, with only two pairs of posterior setae between the major epimeral setae. Fore tarsi without teeth. Fore wings normally with only two distal setae on fore vein.

Abdominal sternites without accessory setae in addition to posterior ones. Abdominal tergite VIII with posterior comb complete.

MALE. Unknown.

Holotype.—Female, Atlas, Pike County, Illinois, October 2, 1953, Smith, Stannard, hibernating in forest ground litter. **Paratypes.**—8 ♀, Ma-

homet, Champaign County, Illinois, November 21, 1948, Bonet, Sanderson, Stannard, hibernating under bark of white oak. 1 ♀, Urbana, Champaign County, Illinois, February 12, 1949, Stannard, under bark.

This species is the color equivalent of the European *albicornis* Knechtel and *latus* (Bagnall). The American *albus* (Moulton) of the West Coast is also light in color, but in this latter species the ocelli are described as absent whereas in *albidus* of Illinois the ocelli are well developed and ringed by red pigments. I have never seen any of the aforementioned supposed relatives of *albidus*, and therefore I cannot fully compare *albidus* with them.

Because *albidus* resembles *Rhoplandrothrips corni*, a western United States thrips, it may be that the two are related. Diagnostic characteristics for the taxon *Rhoplandrothrips* depend upon the form of the male antennae and no males of *albidus* are yet known, precluding precise placement of the species at this time.

Taeniothrips betulae Crawford, J. C.

Taeniothrips betulae Crawford, J. C. (1939:74). ♀, ♂. Type-locality.—Fort Lee, New Jersey.

FEMALE (macropterous).—Length distended about 1.5 mm. Bicolored brown and yellowish brown. Brown: antennal segment II, segments V–VIII, and all of abdomen. Yellowish brown: head, thorax, and legs, although sometimes these regions with much brown. Antennal segment I light brown, segment III nearly yellow, segment IV light brown except base which is yellowish brown. Fore wings yellowish brown. Ocellar pigment red. Body with yellow to orange subintegumental pigment.

Head not elongate or bulged (Fig. 136). Interocellar setae strongly developed. Antennal segments V and VI broadly joined.

Prothorax with a few dorsal setae, with only two pairs of posterior setae between the major epimeral setae. Fore tarsi without teeth. Fore wings normally with only two distal setae on fore vein.

Abdominal sternites without accessory setae in addition to posterior ones. Abdominal tergite VIII with posterior comb complete. Abdominal tergite X split for more than three-fourths its length (Fig. 135).

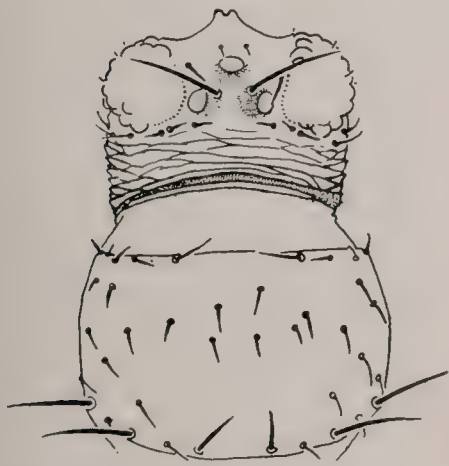


Fig. 136.—*Taeniothrips betulae*, head and prothorax. From O'Neill & Bigelow (1964).

MALE (macropterous).—Length distended about 1.2 mm. Almost entirely yellow to light yellow brown, except antennae which are colored as in female.

Similar to female in structure. Abdominal tergite VIII with a complete posterior comb. Abdominal sternal glandular areas apparently not present.

Similar to the European species, *salicis* (Reuter), *betulae* seemingly occurs on both *Salix* and *Betula*. According to Hood (1927c), J. J. Davis and C. A. Hart first collected it in Illinois in 1908, at which time it was assigned the name *salicis*.

Illinois records.—COOK COUNTY: Riverside, July 14, 1908, on willow (Hood 1927c); Thornton, July 30, 1957, Ross, Stannard, on willow, 1 ♀. KANE COUNTY: Aurora, July 8, 1908, on willow (Hood 1927c). LAKE COUNTY: Wauconda, October 28, 1943, Ross, Sanderson, ground cover, 1 ♀; Zion, July 8, 1947, Sanderson, Stannard, leaves of *Salix cordata*, 9 ♀; Zion, June 18, 1951, Ross, Richards, Stannard, leaves of willow, 5 ♀, 4 ♂. VERMILION COUNTY: Muncie, August 2, 1908, on willow (Hood 1927c).

Taeniothrips inconsequens (Uzel)
Pear Thrips

Physopus inconsequens Uzel (1895: 117). ♀. Type-locality.—Praha (Prague), Czechoslovakia. Bagnall (1909b:5). ♂. Placed in *Taeniothrips* by Bagnall (1916).

Euthrips pyri Daniel (1904:294). ♀. Type-locality.—San Leandro, California. Synonymized by Bagnall (1916) and Williams (1916).

FEMALE (macropterous).—Length distended over 1.5 mm. Color dark brown except antennal segment III and tarsi which are yellowish brown. Ocellar pigments red. Fore wings brown, hind wings pale. Body with much yellow to orange subintegumental pigment.

Head elongate for genus, bulged behind eyes. Interocellar setae well developed. Antennal segments V and VI broadly joined.

Prothorax with scattered dorsal setae, with only two pairs of posterior setae between the major epimeral setae. Fore tarsi each with an apical tooth. Fore wings with three, four, or five distal setae on fore vein.

Abdominal sternites without accessory setae in addition to posterior ones. Abdominal tergite VIII with posterior comb complete. Abdominal tergite X split for about one-half its length.

MALE.—Not in North America; present in Europe (Bagnall 1909*b*; Williams 1916).

To the good fortune of our orchardists, this pest has not yet reached Illinois. The pear thrips, a native of Europe, was introduced as early as 1904 to California and probably later on the East Coast. Either this thrips spreads extremely slowly or there is a biological barrier in the Midwest that prevents its entry here.

In America the pear thrips reproduces entirely by parthenogenesis, since only the female was imported. After a brief but destructive foray on the blossoms and young fruits, the larvae drop to the ground and form pupal cells in the soil. For the next 10 months the larvae, which later change to prepupal and pupal forms, remain hidden in the soil. Then in the spring the pupae transmute and the resultant adults emerge to lay eggs and start the cycle again.

Taeniothrips simplex (Morison)
Gladiolus Thrips

Physothrips simplex Morison (1930*a*: 12). ♀. Type-locality.—Urrbrae, South Australia.

Taeniothrips gladioli Moulton and Steinweden (1931:20). ♀, ♂. Type-locality.—Vineland Station, Ontario, Canada. Synonymized by Steele (1935).

FEMALE (macropterous).—Length distended over 1.5 mm. General color dark brown except antennal segment III and tarsi which are yellowish brown. Fore wings brown except basal portion which is white. Ocellar pigment red. Body with yellow to orange subintegumental pigment.

Head not elongate or especially bulged (Fig. 137). Interocellar setae short. Antennae as in Fig. 130.

Prothorax with a few dorsal setae, with three pairs of posterior setae between the major epimeral setae. Fore tarsi without teeth. Fore wings normally with five or more distal setae on fore vein.

Abdominal sternites III–VII with accessory setae in addition to the posterior ones. Abdominal tergite VIII with posterior comb complete. Abdominal tergite X split for about one-half its length.

MALE (macropterous).—Length distended over 1 mm. Similar to female in color and general structure. Abdominal tergite VIII without a complete posterior comb of setae. Fore wings often with a nearly full row of setae on fore vein. Abdominal sternites III–VIII with accessory setae in addition to posterior ones. Abdominal sternites III–VII each with an elongate sternal area that occupies most of the sclerite (Fig. 132).

Miss Kellie O'Neill of the U.S. National Museum once suggested to me

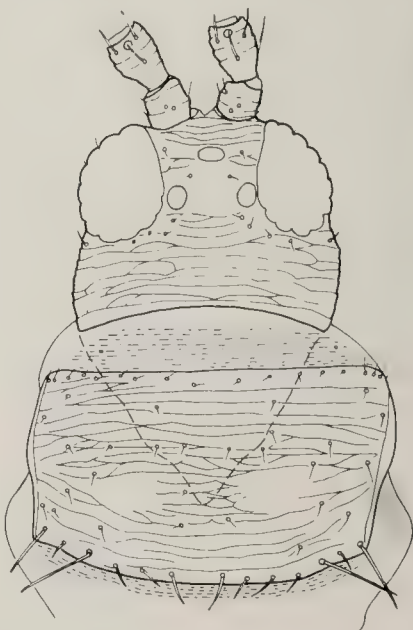


Fig. 137.—*Taeniothrips simplex*, head and prothorax.

that since *simplex* is so dependent upon gladioli, it is probable that this thrips originated from the same area as did its host, that is, from Africa. In Illinois this thrips is of major concern to growers of commercial gladioli as well as to home gardeners. None of these tropical thrips overwinter out-of-doors; the species survives on corms stored in warm buildings.

Speyer (1951) gave an excellent diagnosis of this species and illustrated many of the characteristics. Others have written detailed accounts of the life history of this thrips, among them are Steele (1935), Herr (1934), Smith & Nelson (1933), and Cohic (1953).

Illinois records.—Collected out-of-doors from May to September, as well as in greenhouse in winter, from one to several localities in the following counties: CHAMPAIGN, COOK, KANE, KANKAKEE, MERCER, OGLE, WHITESIDE, and WOODFORD.

Taeniothrips vaccinophilus Hood

Taeniothrips vaccinophilus Hood (1936a:1). ♀. Type-locality.—Candaigua Lake, New York.

FEMALE (macropterous).—Length distended about 1 mm. Color pale yellow. Antennal segments III–VIII and scale and subbasal crossband of fore wing grayish brown. Ocellar pigment red.

Head not elongate or bulged behind eyes. Interocellar setae small.

Prothorax with only a single pair of posterior setae between the major epimeral setae. Fore tarsi without teeth. Fore wings normally with three distal setae on fore vein, fringe cilia wavy (not straight as reported by O'Neill and Bigelow in 1964).

Abdominal sternites without accessory setae in addition to posterior ones. Abdominal tergite VIII without posterior comb. Abdominal tergite X not divided along median line.

MALE (macropterous).—Length distended about 0.7 mm. Similar to female in color and general structure. In the single specimen in our collection, from Connecticut, the left maxillary palp is two segmented whereas the

right maxillary palp is three segmented. Abdominal tergite VIII without posterior comb of setae. Abdominal sternal glandular areas apparently not present.

Although not yet known in Illinois, almost certainly this species will be found here eventually. This assumption is made because host plants of *vaccinophilus*, various species of *Vaccinium*, occur within the state. I have seen specimens from Connecticut, New York (including the holotype), and Washington, D.C.

Taeniothrips vulgatissimus (Haliday)

Thrips vulgatissima Haliday (1836:447). ? ♀. Type-locality.—Britain. Placed in *Taeniothrips* by Priesner (1920a).

Physopus pallipennis Uzel (1895:110). ♀. Type-locality.—Either Bohemia (Czechoslovakia) or Helgoland (Germany). Synonymized by Priesner (1914a).

FEMALE (macropterous).—Length distended up to nearly 2 mm. Color nearly uniformly dark brown except antennal segment III and tarsi which are lighter brown. Fore wings brown except base which is dusky white. Ocellar pigment red. Body, especially thorax, with orange to red subintegumental pigment.

Head slightly elongate for genus, slightly bulged behind eyes (Fig. 138). Antennae as in Fig. 131. Interocellar setae moderately long.

Prothorax moderately setose, with three pairs of posterior setae between the major epimeral setae. Fore tarsi without teeth. Fore wings normally with three distal setae on fore vein.

Abdominal sternites with accessory setae in addition to posterior ones. Abdominal tergite VIII with posterior comb complete. Abdominal tergite X split for more than three-fourths its length (Fig. 134).

MALE (macropterous).—Length distended nearly 1.5 mm. Similar to female except somewhat lighter color in thorax. Abdominal sternites III–VIII with accessory setae in addition to posterior ones. Abdominal sternites III

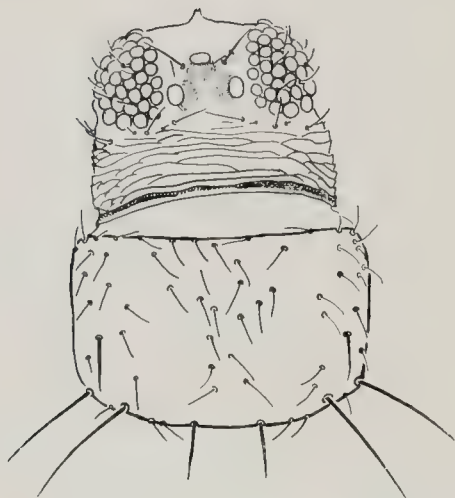


Fig. 138.—*Taeniothrips vulgatissimus*, head and prothorax. From O'Neill & Bigelow (1964).

VII with a small oval glandular area (Fig. 133). Abdominal tergite VIII without posterior comb of setae.

Seemingly this is a species with an enormous natural range. It has been found in northern, western, and middle Europe (Priesner 1926b) and in much of temperate North America. As might be expected in a species of extensive distribution throughout which it is subjected to varied ecological conditions, there are considerable interpopulation differences. In particular the lengths of certain setae and the size of the male glandular areas often vary between populations. Yet, it seems certain that all of these populations belong to *vulgatissimus*, perhaps in some cases as racial or even subspecific segregates.

In Illinois *vulgatissimus* becomes abundant solely on *Heracleum*, its principal host plant. In Europe, too, *Heracleum* is a favorite host. I have for comparison many specimens collected by Dr. H. H. Ross from *Heracleum* that was growing in an English garden. Both the English and the Illinois specimens appear to be the same species.

Illinois records.—COOK COUNTY: Golf (Harm's Woods), June 17, 1949, Ross, Tietz, Stannard, on *Heracleum*, many specimens; Western Springs

(Warren Harding Woods), June 16, 1949, Ross, Stannard, on *Heracleum*, 3 ♀. LAKE COUNTY: Waukegan, June 18, 1951, Ross, Richards, Stannard, on flowers of *Heracleum*, 6 ♀, 1 ♂. WINNEBAGO COUNTY: Shirland, July 29, 1953, Stannard, in woods, 1 ♀.

Thrips Linneaus

Thrips Linneaus (1758:457). Type-species by subsequent designation by Curtis (1839).—*Thrips physapus* Linneaus. Valid designation. Type-species by subsequent designation by Westwood (1839).—*Thrips physapus* Linneaus. Unnecessary designation, previously designated by Curtis.

Physapus DeGeer (1773:6).—Name used in subordination to *Thrips*.

Euthrips Targioni-Tozzetti (1881:132). Unnecessary substitute name for *Thrips* (Hood 1914a).

Parathrips Karny (1907:47). Type-species by monotypy.—*Parathrips uzeli* Karny. Synonymized by Priesner (1925c).

Achaetothrips Karny (1908:111). Type-species by monotypy.—*Achaetothrips loboptera* Karny. Synonymized by Priesner (1949).

Archaeothrips Field (1910:74). Misspelling of *Achaetothrips* Karny.

Paulus Solowiow (1924:25). Type-species by monotypy.—*Paulus gracilis*. Synonymized by Priesner (1949).

Priesneria Maltback (1928:2). Type-species said by Priesner (1949) to be *Priesneria maneosetosa* Maltback; reference unknown to me. Preoccupied by *Priesneria* Bagnall (1926c). Synonymized by Priesner (1949).

Head wider than long to as long as wide, at the most only slightly prolonged in front of eyes. Antennae seven segmented, segments III and IV each with a forked sense cone. Antennal segment VI sometimes slightly enlarged in male. Interocellar and postocular setae small. Mouth cone moderate in size. Ocelli, except when reduced in size, forming a fairly compact triangle. Maxillary palps three segmented.

Prothorax with two well-developed pairs of epimeral setae, all other setae much smaller by comparison, with two, three, or four pairs of setae on posterior margin between major pairs of epimeral setae. Mesospinasternum separated from metasternum by a wide suture. Metascutum longitudinally striate to hexagonally reticulate. Fore legs rarely with toothlike projections and always without long hairlike projections. All tarsi two segmented. Macropterous, micropterous, or brachypterous. Fore wings with two veins, setae on veins interrupted on fore vein only, fringe cilia wavy.

Abdomen with separated pleural plates. Abdominal tergite I weakly to strongly striate. Abdominal tergite II with three or four setae on each lateral margin. Median pair of setae placed far apart on the intermediate abdominal tergites. Abdominal tergites with or without small scallop-like projections along posterior margins. Abdominal sternites with or without accessory setae, median posterior pair of setae on margin except on sternite VII. Abdominal tergite VIII with or without a complete comb of marginal setae. Females with well-developed ovipositor, with abdominal tergite X partially split. Males with a glandular area on either abdominal sternites III and IV, III-V, or more usually III-VII; these glandular areas round to oval to transversely elongate. Males without thornlike setae on abdominal tergite IX.

This is the only genus Linneaus recognized in the group of insects that has since become known as the Thysanoptera.

From the closely related *Baliothrips*, the genus *Thrips* may be separated by the number of segments in the maxillary palps. *Baliothrips* is characterized by having the maxillary palps two segmented whereas in the species of *Thrips* the maxillary palps are three segmented. From *Microcephalothrips* the genus *Thrips* differs primarily in the number of setae on the posterior margin of the prothorax between the major pairs of epimeral setae. In *Microcephalothrips*, as found in Illinois, there are five pairs of setae between

the major epimeral setae. By contrast in the species of *Thrips*, as found in Illinois, there are only two, three, or rarely four pairs of setae between the major epimeral setae.

Thysanopterists are indebted to E. R. Speyer of England for his excellent analysis of the genus *Thrips* and in particular for his discovery of many useful diagnostic characteristics.

Thirteen species occur in Illinois. Of those whose habits are known six are host specific, that is, each of these species is confined for its existence to a single genus of plants.

KEY TO SPECIES
(THAT OCCUR OR MAY OCCUR IN ILLINOIS)

- 1. Females2
Males (not keyed: *helianthi* and *monotropae* which are unknown, and *nigropilosus* which is unknown to me) ...19
- 2. Macropterous3
Brachypterous18
- 3. Abdominal sternites with accessory (middle row) setae*physapus*
Abdominal sternites without accessory setae4
- 4. Posterior margin of abdominal tergite VIII predominantly with non-setae-bearing, scalelike projections. *sylvanus*
Posterior margin of abdominal tergite VIII with setae (some of which may be borne on tiny scalelike projections) or posterior margin mostly bare.5
- 5. Antennal segments I and II dark, nearly uniformly yellow in the remaining segments although segments VI and VII may be slightly shaded brown; legs entirely dark.*pallicornis*
Antennae brown apically, especially segments VI and VII; legs dark, or tarsi and/or parts or all of tibiae yellow, or legs entirely pale yellow.6
- 6. Fore wings brown in the middle, markedly pale basally and apically. *helianthi*
Fore wings uniformly brown or entirely pale gray, or pale gray at base, or just slightly paler at apex7
- 7. Apical half of anterior longitudinal vein of fore wing usually with four to six setae; basal setae short, hardly longer than distance between fore vein and leading edge of wing; prothorax with major setae short, much shorter than dorsal length of eye; ocellar pigments gray in life.*tabaci*
Apical half of anterior longitudinal vein of fore wing usually with three or fewer setae; basal setae longer, when perpendicular considerably exceeding the leading edge of the wing; prothorax usually with major setae as long as or longer than dorsal length of eye; ocellar pigments some shade of red.8
- 8. Light colored species, wings and abdomen

- yellow to light yellow-brown in spots, wing and abdomen never predominantly brown to black 9
 Dark colored species, at least most of abdomen and wings grayish brown to black 12
9. Head, prothorax and abdomen with light yellowish brown blotches. *nigropilosus*
 Body almost entirely pale yellow. 10
10. Abdominal tergite II with four setae on each lateral margin (not yet introduced into Illinois). *flavus*
 Abdominal tergite II with three setae on each lateral margin. 11
11. Body and wing bristles dark brown *winnemanae*
 Body and wing bristles almost colorless. *quinciensis*
12. Bicolored; brownish yellow on head, thorax, abdominal segments I, IX, and X; abruptly dark brown on abdominal segments II-VIII. *tripartitus*
 Not abruptly paler in color on abdominal segments I, IX and X. 13
13. Abdominal tergite II with four setae on each lateral margin. *fuscipennis*
 Abdominal tergite II with three setae on each lateral margin. 14
14. Comb along posterior margin of abdominal tergite VIII interrupted in the middle. 15
 Comb along posterior margin of abdominal tergite VIII complete. 16
15. Interocellar setae much shorter than the length of antennal segment II. . . *varipes*
 Interocellar setae as long as or longer than the length of antennal segment II (not yet found in Illinois). . . *spinosus*
16. Antennal segments IV and V, at least, yellow to yellowish brown in basal two-thirds. *frosti*
 Antennal segments IV and V brown or brownish gray. 17
17. Head pale brown beyond ocelli becoming yellow; abdominal segments IX and X brown; antennal segments III and IV relatively slender. *impar*
 Head brown forward of ocelli; abdominal segments IX and X brown to brownish yellow; antennal segments III and IV stouter. *monotropae*
18. Body pale, yellow with gray. *nigropilosus*
 Body bicolored yellow and black, abdominal segments II-VIII dark brown . . . *tripartitus*
19. Abdominal sternites with one or two pairs of accessory setae. *physapus*
 Abdominal sternites without accessory setae. 20
20. Abdominal glandular areas only on sternites III and IV, or III-V. 21
 Abdominal glandular areas on sternites III-VII. 22
21. Abdominal glandular areas on sternites III and IV only. *pallicornis*
 Abdominal glandular areas on sternites III-V. *tabaci*
22. Abdominal tergite II with four setae on each lateral margin. 23
 Abdominal tergite II with three setae on each lateral margin. 24
23. Color yellow (not yet introduced into Illinois). *flavus*
 Color brown or brownish yellow. *fuscipennis*
24. Abdomen markedly bicolored; abdominal segments I, IX, and X yellowish brown; segments II-VIII abruptly brown. *tripartitus*
 Abdomen not markedly bicolored. 25
25. Abdominal tergite IX with four anterior setae and two posterior setae. . *varipes*
 Abdominal tergite IX with two anterior setae and four posterior setae. 26
26. Antennal segment I brown. 27
 Antennal segment I yellow to pale or pale gray. 29
27. Interocellar setae much shorter than the length of antennal segment II. 28
 Interocellar setae as long as or longer than antennal segment II (not yet found in Illinois). *spinosus*
28. Antennal segment V yellow in basal two-thirds; fore wings only slightly lighter in color at base; abdominal sternal glands relatively large. *frosti*
 Antennal segment V with more brown; abdominal sternal glands smaller; fore wings abruptly pale in color at base. . . *sylvanus*
29. Wings pale gray. *quinciensis*
 Wings predominantly brown or grayish brown. 30
30. Prothorax and metascutum light brown *impar*
 Thorax entirely yellow. . . *winnemanae*.

Thrips frosti Moulton

Thrips frosti Moulton (1936c:107). ♀, ♂. Type-locality.—Sherborn, Massachusetts.

FEMALE (macropterous).—Length distended about 1.4 mm. General color dark brown. Antennal segment III yellowish brown, apical two-thirds of segments IV and V usually yellow, remainder of antennae predominantly dark brown. Apical half of tibiae and all tarsi yellowish brown to yellow. Fore wings dark brown becoming slightly lighter at base. Ocellar pigment red. Body with red subintegumental pigment.

Head moderate in size. Antennal segment III slender.

Prothorax moderately setose, with bare areas either side of center. Anteromarginal setae heavy and thickened. Inner posterior pair of major setae long, about $1\frac{1}{2}$ times as long as dorsal length of eye. Three pairs of setae on posterior margin of the prothorax between the major pairs of setae. Fore wings each with three (sometimes four) apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII with a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended about 1 mm. Colored dark brown much as in female, except slightly lighter in head.

Similar to female in structure. Abdominal sternal glands moderate in size, oval, one each present on sternites III–VII. Abdominal tergite VIII apparently without a complete comb of setae on posterior margin. Abdominal tergite IX with two anterior and four posterior median setae.

This species belongs to the *monotropae-impar* group of dark brown species possessing a complete comb of setae on the posterior margin of abdominal tergite VIII. It differs from both *monotropae* and *impar* by the lighter colored intermediate antennal segments. Possibly *frosti* is also related to *herricki*, but *herricki* is said to differ by having most of antennal segments IV and V brown, much as in *impar* and *monotropae*.

Since its description, *frosti* has not been reported again in the literature. In 1955 we were fortunate in finding several specimens of this species in the Quetico Provincial Park, a wilderness area in Ontario. Although almost certainly a northern thrips, *frosti* eventually might be found in the relict boreal areas of northern Illinois. So far no specimen has been collected in our state.

***Thrips fuscipennis* Haliday**

Thrips fuscipennis Haliday (1836: 448). *Nomen nudum*.

Thrips fuscipennis Haliday (1852: 1111). ♀, ♂. Type-locality.—Presumably England. First valid description.

Thrips salicaria Uzel (1895:182). ♀, ♂. Type-locality.—Czechoslovakia. Synonymized by Priesner (1925c).

Thrips meledensis Karny (1908:110). ? ♀. Type-locality.—Prozor, Yugoslavia. Synonymized by Priesner (1925c).

FEMALE (macropterous).—Length distended about 1.4 mm. Body color

varying from light brown to dark brown. Antennae brown except intermediate segments which are sometimes yellowish brown. Tarsi yellowish brown. Fore wings nearly uniformly gray-brown becoming slightly paler at base. Ocellar pigment red. Thorax with orange subintegumental pigment.

Head moderate in size.

Prothorax moderately setose, with bare areas on either side of center. Inner posterior pair of major setae moderately long, about as long as dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings each with two or three apical setae on fore vein.

Abdominal tergite II usually with four setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII usually without a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended about 0.9 mm. General color yellowish brown. Head forward of ocelli and directly behind eyes, antennal segment I, and anterior margin of prothorax yellow. Thorax and abdomen sometimes predominantly more brown than yellowish brown. Similar to female in other coloration.

Similar to female, except more slender, in general structure. Abdominal sternites III–VII each with a fairly large, elliptical glandular area. Abdominal tergite IX with two anterior and four posterior median setae.

This variable and common European species is apparently also present in our fauna. Our specimens compare favorably with material I have studied from England and Germany. Possibly it was introduced by man, because according to Morison (1948) it is apparently limited by climatic factors to southern England and thus cold temperatures would have prevented it from becoming holarctic in natural distribution in recent times. *Thrips fuscipennis* was first reported in North America (New York) by Hood in 1927. In England it is called the "rose thrips" (Speyer 1934) although it is numerous on other flowers and trees as well (Morison 1948).

From other dark colored species of the genus *Thrips* that occur in Illinois, *fuscipennis* may be distinguished by the lack of accessory setae on the abdominal sternites, by the absence of a complete comb of setae on abdominal tergite VIII, and by the presence of four setae on each lateral margin of abdominal tergite II.

So far this species has been found only in northern Illinois. To my knowledge no males have been taken in North America.

Illinois records.—LAKE COUNTY: Volo Bog, October 18, 1952, McAlpine, 1 ♀. PUTNAM COUNTY: Magnolia, April 29, 1948, Stannard, on *Fraxinus* leaves, 4 ♀.

Thrips helianthi Morgan

Thrips helianthi Morgan (1913:23).
♀. Type-locality.—Clarksville, Tennessee.

Thrips walteri Crawford, J. C. (1938: 37). ♀. Type-locality.—Washington (Mount Hamilton), D. C. Synonymized by Bailey (1948).

FEMALE (macropterous).—Length distended about 1.4 mm. General color dark brown. Antennal segments I and II dark brown; segments III–V predominantly yellow, darkened apically; segment VI yellow at base, light brown in apical half; segment VII light brown. Apical half of tibiae and all tarsi yellow. Fore wings pale brown at base and apex, brown in the middle. Ocellar pigment red.

Head moderate in size. Antennal segment VI slightly longer than segment III.

Prothorax moderately setose with bare areas either side of center. Anterior margin of prothorax with one or two pairs of stouter setae. Inner posterior pair of major setae of prothorax moderately long, about as long as to slightly longer than dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings with two or three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal

tergite VIII with a complete comb of setae on posterior margin.

MALE.—Unknown.

From all other congeners known to occur in Illinois, this species may be distinguished by the color of the fore wings, which are brown in the middle and abruptly pale at the base and apex.

This rare thrips has been taken four times in our state.

Illinois records.—ADAMS COUNTY: Marblehead, June 24, 1948, Stannard, sweeping in woods, 1 ♀. MCHENRY COUNTY: Hebron, July 29, 1953, Stannard, edge of marsh, 1 ♀. TAZEWELL COUNTY: Hopedale, September 11, 1953, Ross, Stannard, herbs of floodplain forest, 1 ♀. VERMILION COUNTY: Danville, November 1, 1942, Ross, ground litter, 1 ♀.

Thrips impar Hood

Thrips impar Hood (1915a:25). ♀, ♂.

Type-locality.—Not stated but holotype labeled Plummer's Island, Maryland.

Thrips herricki var. *impatientis* Moulton (1936c:109). ♀. Type-locality.—Atwater, Illinois, New synonymy.

FEMALE (macropterous).—Length distended about 1.4 mm. General color brown. Antennae brown except pedicels of intermediate segments lighter. Head forward of ocelli yellow. Tibiae and tarsi yellowish brown to yellow. Fore wings nearly uniformly brownish gray, not particularly paler at base. Ocellar pigment red. Thorax with orange subintegumental pigment.

Head moderate in size. Antennal segment VI nearly equal to slightly longer than segment III, segments III and IV slender.

Prothorax moderately setose, with bare areas on either side of center. Inner posterior pair of major setae long, more than $1\frac{1}{4}$ times as long as dorsal length of eye. Two, occasionally three, pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings with two or three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites

without accessory setae. Abdominal tergite VIII with a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended about 1.1 mm. Body and legs generally yellow clouded with pale brown blotches. Antennal segment I pale yellow, remainder of antennae brown. Fore wings nearly uniformly brownish gray similar to those of female.

Similar to female in structure except smaller and more slender. Antennal segment VI proportionately longer than in female. Abdominal sternal glands moderate in size, usually elliptical, one each present on sternites III–VII (Fig. 49). Abdominal tergite VIII usually without a complete comb of setae on posterior margin. Abdominal tergite IX with two anterior and four posterior median setae.

This species is similar to *monotropae* in many characteristics. In the female sex, the two species differ in color and in the shape of antennal segments III and IV, as noted in the key. Because the male of *monotropae* is unknown, a comparison of this sex cannot be made. An additional point of difference may be in the number of setae on the posterior margin of the prothorax between the major pairs. This difference may apply to both sexes. Usually in the species *impar* only two pairs of setae are present in this region, whereas in *monotropae* there are usually three pairs of setae.

Through the kindness of Dr. E. S. Ross I have been able to check a female paratype of Moulton's *Thrips herricki* var. *impatiens*. I found that this paratype is identical with material determined as *impar* by many American thysanopterists.

It has been long suspected that *Thrips herricki* Bagnall and its many synonyms, Hood (1931a), may be in turn a synonym of *impar*. Proof of this synonymy remains to be obtained.

Thrips impar is common throughout the state on jewelweed (*Impatiens*). It is recorded in the literature from Georgia, Maryland, New Jersey, New York, and Tennessee. I have taken it also in Arkansas, Indiana, and Ohio.

Illinois records.—Collected from

May through September, from one to several localities in the following counties: ADAMS, BROWN, BUREAU, CALHOUN, CARROLL, CHAMPAIGN, CHRISTIAN, CLARK, COOK, CUMBERLAND, DOUGLAS, EDGAR, EFFINGHAM, FULTON, HARDIN, HENDERSON, HENRY, JACKSON, JERSEY, JO DAVIESS, KENDALL, LAKE, LA SALLE, LEE, MACON, MACOUPIN, MASON, MASSAC, MERCER, MONROE, OGLE, PUTNAM, SCOTT, SHELBY, STEVENSON, TAZEWELL, VERMILION, WABASH, WARREN, WILL, and WILLIAMSON.

Thrips monotropae Hood

Thrips monotropae Hood (1927a:217).

♀. Type-locality.—Sodus Point, New York.

Thrips flavicauda Watson (1927b:43).

♀, ♂. Type-locality.—Gainesville, Florida. New synonymy.

FEMALE (macropterous).—Length distended about 1.5 mm. General color dark brown. Antennae almost entirely dark brown, the pedicels of the intermediate segments yellowish brown. Tibiae and tarsi yellowish brown to yellow. Abdominal segments IX and X brown to yellowish brown. Fore wings brown becoming gradually paler at base. Ocellar pigment red. Thorax with orange subintegumental pigment. Body setae brown.

Head (Fig. 139) moderate in size. Antennal segment VI nearly equal to or longer than segment III, segment III moderately stout.

Prothorax moderately setose, with bare areas either side of center posteriorly. Inner posterior pair of major setae long, nearly $1\frac{1}{2}$ times as long as dorsal length of eye. Three, occasionally two, pairs of setae on posterior margins of prothorax between the major pairs of setae. Fore wings with three apical setae on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII with a complete comb of setae on posterior margin.

MALE.—Unknown.

This species has a darker head and stouter third and fourth antennal segments than does its close relative,



Fig. 139.—*Thrips monotropae*, head and prothorax. From Hood (1927c).

impar. Many Illinois specimens of *monotropae* have the last two abdominal segments light brown. In contrast eastern specimens often have abdominal segments IX and X yellowish brown.

As its name implies, *Thrips monotropae* occurs in the flowers of Indian pipe (*Monotropa uniflora* and *Monotropa hypopithys*). It has been found several times in Illinois but apparently it is only locally abundant. Repeated efforts to find *monotropae* in areas other than those listed below for our state have not been successful. In addition to the Illinois material there are specimens in our collection from Wheaton, Maryland and Mt. Carmel, Connecticut collected by Dr. K. M. Sommerman, and specimens from Chelsea, Quebec collected by Dr. R. S. Bigelow.

Although Watson (1927b) thought that *flavicauda* was different from *monotropae* he did not state the reasons for his belief. In my opinion the two are conspecific. I am here designating the lectotype of *flavicauda* to

be the dorsally mounted female specimen on the slide marked "Type" with the prefix "para" crossed off. This slide is labeled "In blossoms of Indian pipe under oaks, Lakeside Estate, Gainesville, Fla., 12-7-26, Watson & Tissot". Another female, mounted on its side, lies next to the lectotype on the same slide, which is deposited in the Watson collection.

Illinois records.—LA SALLE COUNTY: Starved Rock State Park, September 7, 1951, Mills, Ross, in flowers of *Monotropa uniflora*, 6 ♀, 1 larva; Starved Rock State Park, September 13, 1951, Richards, Stannard, in *Monotropa* flowers, 6 ♀. OGLE COUNTY: Oregon (Sinnissippi Forest), September 15, 1955, Ross, Stannard, in flowers of Indian pipe, 3 ♀.

***Thrips nigropilosus* Uzel** Chrysanthemum Thrips

Thrips nigropilosus Uzel (1895:198). ♀, ♂. Type-locality.—Czechoslovakia.

Thrips aureus Hood (1915a:27). ♀, ♂. Type-locality.—Alexandria, Virginia. New synonymy.

FEMALE (macropterous).—Length distended about 1.5 mm. Color yellow with light grayish brown blotches on the thorax and the basal abdominal tergites. Antennal segment I nearly white; remaining segments brown. Ocellar pigment red. Body setae dark brown. Fore wings pale gray.

Head moderate in size.

Prothorax moderately setose, setae fairly long, with a well-developed pair of anterior setae, with bare areas either side of center. Inner posterior pair of major setae proportionately long, nearly $1\frac{1}{2}$ times as long as dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs. Fore wings short with three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII with a complete comb of setae on posterior margin.

FEMALE (brachypterous).—Color

and structure similar to macropterous form except wings shortened to pads.

MALE.—Not yet found in Illinois, nor represented in the collections of the Illinois Natural History Survey.

Thrips nigropilosus is a yellow thrips with light grayish brown blotches and red ocellar pigment. It is one of the few species of *Thrips* in Illinois that produces brachypterous forms.

Apparently introduced from Europe, this thrips prefers our roadsides which are composed primarily of introduced European plants. It is common locally in the northern part of Illinois where I have taken it in large numbers on burdock. Before the general use of the newer insecticides, *nigropilosus* was a pest in greenhouses, especially on chrysanthemums.

Illinois records.—CHAMPAIGN COUNTY: Urbana, February 18, 1937, Asterlund, (in greenhouse) on chrysanthemum, many specimens; Urbana, April 5, 1939, Ritcher, (in greenhouse) on chrysanthemum, 4 ♀; Urbana, June 23, 1933, Farrar, lettuce, 2 ♀. COOK COUNTY: Maywood, February 5, 1935, Compton, (in greenhouse) on *Matricaria parthenoides*, many specimens. DU PAGE COUNTY: Naperville, February 20, 1925, Compton, (in greenhouse) on chrysanthemum, many specimens. JACKSON COUNTY: Gorham (Fountain Bluff), April 30, 1953, Stannard, grass, 1 ♀. MCHENRY COUNTY: Chemung, June 19, 1951, Stannard, underside of leaves of burdock, many specimens. WABASH COUNTY: Mt. Carmel, June 15, 1948, Becker, grasses, 2 ♀.

Thrips pallicornis Hood

Thrips pallicornis Hood (1912c:138). ♀, ♂. Type-locality.—Parker, Johnson County, Illinois.

Thrips gilmorei Moulton (1929b:234). ♀, ♂. Type-locality.—Appomattox, Virginia. New synonymy.

FEMALE (macropterous).—Length distended over 1.5 mm. General color dark brown including legs. Antennal segments I and II dark brown, remaining segments yellow except apical half of segment VI and all of VII

faintly clouded with light brown. Fore wings brown, abruptly pale at base. Ocellar pigment red. Body with bright red subintegumental pigment.

Head elongate. Antennal segments III and IV slender.

Prothorax sparsely setose, the central area almost devoid of setae. Inner major pair of posterior setae of prothorax long, more than $1\frac{1}{4}$ times as long as dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings with three apical bristles on fore vein.

Abdominal tergite II usually with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII with a complete but weak comb of setae on posterior margin.

MALE (macropterous).—Length distended about 1.3 mm. Similar to female in color and general structure, except smaller and more slender. Abdominal sternal glandular areas large, elliptical, one each on sternites III and IV only (Fig. 48). Abdominal tergite VIII without a complete comb of setae on posterior margin.

The light-colored antennae contrasted to the dark-colored body and legs give *pallicornis* a distinctive appearance, although somewhat suggestive of *sylvanus*. The male of *pallicornis* is unusual in that it has only two sternal glandular areas on the abdomen.

This species occurs on hickory leaves in the west-central and southern parts of the state. So far it has not been found within the area formerly glaciated by the Wisconsin ice sheets.

Illinois records.—Collected during spring, summer and early fall, from one to several localities in the following counties: ADAMS, CALHOUN, CLAY, JACKSON, JOHNSON, MC-DONOUGH, PIKE, POPE, RICHLAND, WASHINGTON, and WILLIAMSON.

Thrips physapus Linnaeus Dandelion Thrips

Thrips physapus Linnaeus (1758:457).

♀. Type-locality.—Sweden.

Thrips fusca Müller (1776:96). ? ♀.

Type-locality.—Denmark or Norway. Synonymized by Priesner (1925c).

Thrips flavicornis Reuter, O. M. (1878-79:219). ? ♀. Type-locality.—Paragas (Parainen), Turku-Pori, Finland. Synonymized by Reuter (1899).

FEMALE (macropterous) (Fig. 140).—Length distended about 1.7 mm.

General color dark brown. Antennal segments III–VII largely yellow, apex of segments IV–VI and all of VII brown. Fore tibiae, except at sides, and all tarsi yellow to yellow-brown. Fore wings nearly uniformly grayish

brown. Ocellar pigment red. Thorax with orange subintegumental pigment.

Head moderate in size, eyes large.

Prothorax setose but with bare areas either side of center posteriorly. Inner posterior pair of prothoracic setae short, less than dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings with three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites with accessory setae variously arranged, not in a single transverse row. Abdominal tergite VIII with a com-

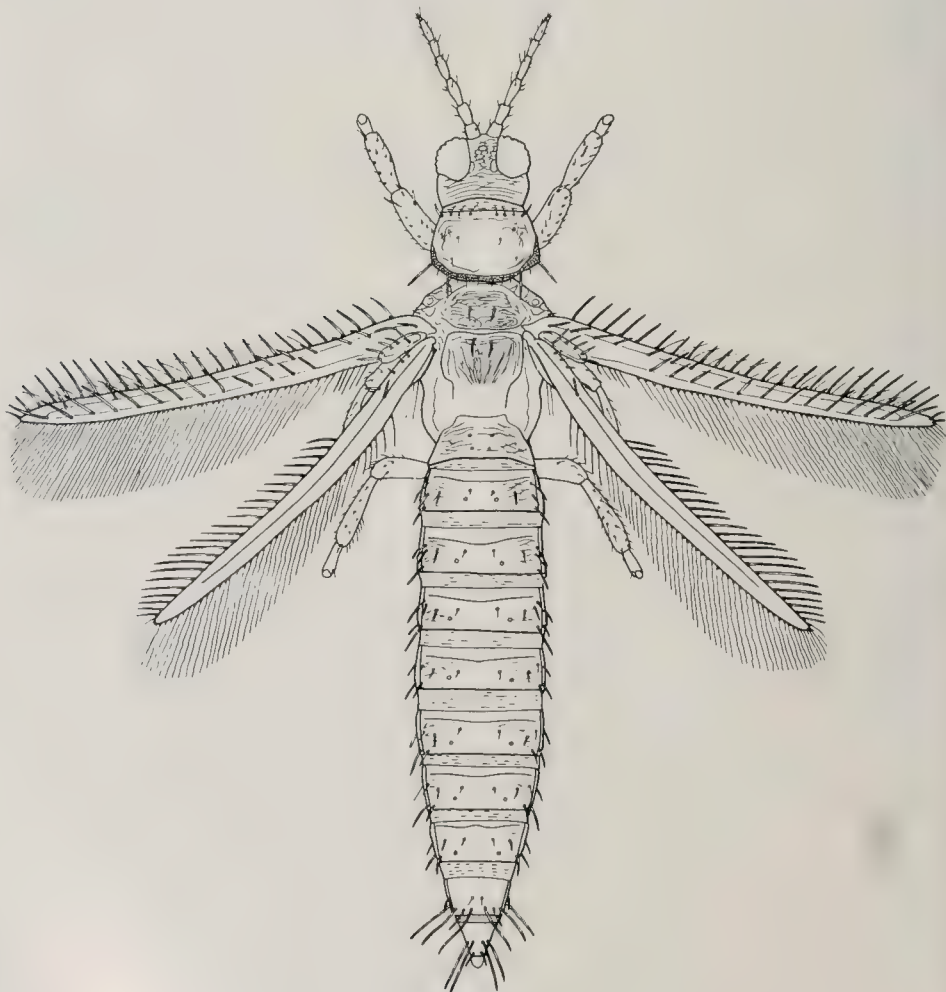


Fig. 140.—*Thrips physapus*, dorsal aspect.

plete comb of setae on posterior margin.

MALE (macropterous).—Length distended over 1.2 mm. Similar to female in color and structure except lighter colored and more slender. Abdominal sternites with fewer accessory setae (usually reduced to two or four setae) than in female. Abdominal sternites III–VII each with a moderate-sized, elliptical glandular area. Abdominal tergite VII without a complete comb of setae on posterior margin.

It is my opinion, based upon comparative studies of European specimens, that our species in Illinois is *Thrips physapus* as defined by Speyer and others. Presumably this thrips was introduced into North America from Europe along with its host plants. *Thrips trehernei* Priesner which was later made a variety of *Thrips hukkineni* Priesner (Priesner 1937) is probably not the proper name for our species.

Thrips physapus is the only species of the genus *Thrips* in Illinois with accessory setae on the abdominal sternites. Reported elsewhere in eastern North America, other species having accessory setae on the abdominal sternites differ in that either they possess a tooth on each fore tarsus (*Thrips calcaratus* Uzel) or the accessory setae are arranged in a single transverse row on each abdominal sternite (*Thrips thalictri* Hood).

Dandelion (*Taraxacum*), goatsbeard (*Tragopogon*), and wild lettuce (*Lactuca*) appear to be the favorite hosts of this common, statewide thrips.

Illinois records.—Collected during spring, summer, and autumn from one to several localities in every county in the state.

Thrips quinciensis Morgan

Thrips quinciensis Morgan (1913:21).

♀. Type-locality.—Quincy, Florida.

?*Thrips pectinatus* Hood (1932:38).

♀. Type-locality.—Plummer's Island, Maryland. ? new synonymy.

FEMALE (macropterous).—Length distended about 1.3 mm. Color almost entirely pale yellow becoming nearly

white in Hoyer's mounting medium, wings and body setae also pale. Antennae predominantly yellowish but terminal segments with much brown, segments II–IV with indications of brown at tip, segment V brown in the apical half, segment VI brown in the apical two-thirds, and segment VII brown. Ocellar pigment red.

Head moderate in size.

Prothorax moderately setose with bare areas either side of center. Inner posterior pair of major prothoracic setae long, nearly $1\frac{1}{2}$ times as long as dorsal length of eye. Two or three pairs of setae on posterior margin of prothorax between the major pairs. Fore wings with two or three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII with a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended about 1.1 mm. Similar to female in color and general structure. Abdominal tergite VIII usually with a complete comb of setae on posterior margin but these setae shorter and much weaker than in female. Abdominal sternal glandular areas on sternites III–VII inclusive, these glandular areas small, usually not as wide as the distance between the bases of the median pair of posterior sternal setae. Abdominal tergite IX with two anterior and four posterior setae.

Thrips quinciensis is a pale colored thrips with bright red ocellar pigment, with most of the basal segments of the antennae pale, and with the body setae pale to nearly colorless. By the combination of these characteristics it can be distinguished from any species of *Thrips* so far discovered in Illinois.

Like *winnemanae*, *quinciensis* was reported to have been collected more than 40 years ago and hardly again since. It may be a rare but locally common thrips; I have taken it in abundance in the Great Smoky Mountains National Park and we have records of it from hibernation in the forest leaf mold from Michigan and Wisconsin. It is known from one locality in

Illinois where larvae and adults were found feeding on the leaves of *Staphylea*.

The types of *quinciensis* do not show evidence of a complete comb of setae across the posterior margins of abdominal tergite VIII in the female. This absence of setae is presumed to be due to the poor mounts of the specimens. If, on the other hand, it is found that these setae are really lacking in *quinciensis*, then the Illinois populations should be referred to as *pectinatus*.

Illinois record.—PIKE COUNTY: Barry, September 9, 1954, Ross, Stannard, on leaves of *Staphylea*, 1 ♀, 6 larvae.

***Thrips spinosus* Morgan**

Thrips spinosus Morgan (1913:25).
♀, ♂. Type-locality.—Quincy, Florida.

FEMALE (macropterous).—Length distended about 1.6 mm. General color brown with abdominal segment X dark brown. Antennal segment III yellow to yellowish brown in basal half, segments IV and V yellow at extreme base. Apical half of tibiae and all of tarsi yellow. Fore wings nearly uniformly dusky brown. Ocellar pigment red.

Head (Fig. 141) moderate in size with moderately well-developed interocellar setae, these setae longer than antennal segment II.

Prothorax moderately setose with bare areas either side of center. Inner posterior pair of major setae moderately long, about as long as dorsal length of eye. Three or four pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings with three apical setae on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII without a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended at least 1.2 mm. Similar to female in color and structure. Abdominal sternites III–VII each with a very large, elliptical glandular area, these areas much larger than in *fusci-*

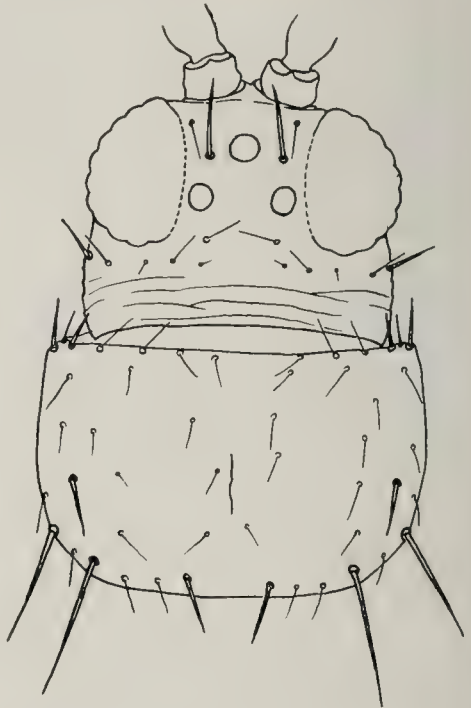


Fig. 141.—*Thrips spinosus*, ♂, head and prothorax.

pennis, about the size of those found in *varipes*. Abdominal tergite IX with two anterior and four posterior median setae.

This brown species may be distinguished from other similarly colored entities by the long interocellar setae.

Presumably *spinosus* is host specific to magnolias (Watson 1924a). Although it has not been found in our state as yet, it may be discovered eventually in southern Illinois on native and cultivated magnolias. It has been reported to be in Indiana (Blickenstaff 1946).

***Thrips sylvanus* Stannard**

Thrips sylvanus Stannard (1957a:174).
♀, ♂. Type-locality.—Great Smoky Mountains National Park, Tennessee.

FEMALE (macropterous).—Length distended about 1.4 mm. General color dark brown. Antennal segments I and II dark brown, remainder of antennae usually bright yellow but often fading

into brown in segments VI and VII, sometimes in segment V also. Apexes of tibiae and all of each tarsus yellow, the fore tibiae being the lightest. Fore wings abruptly pale at base, uniformly brown in the remainder of the wing. Ocellar pigment red.

Prothorax moderately setose with bare areas either side of center. Inner posterior pair of major setae short, much shorter than dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs. Fore wings with two apical setae on fore vein.

Abdominal tergite II with four (sometimes three) setae on each lateral margin. Sternites without accessory setae. Posterior margin of abdominal tergite VIII fringed with scalelike projections. Most of the other abdominal segments similarly fringed but with the scalelike projections weaker.

MALE (macropterous).—Length distended about 1 mm. Similar to female in general color and structure. Small abdominal glandular areas present, one each on sternites III–VII, gradually changing from elliptical on segment III to nearly circular on sternite VII. Abdominal tergite IX with two anterior and four posterior setae.

This species is easily distinguished by the presence of scalelike projections along the posterior margin of abdominal tergite VIII. In this respect, but to a lesser degree, *syllvanus* is similar to *Microcephalothrips abdominalis*.

So far *syllvanus* has been found in only three localities in Illinois. Its hosts (or host) have not been determined.

Illinois records.—CLARK COUNTY: Marshall, May 13, 1949, Ross, Gloyd, Stannard, 1 ♀. HARDIN COUNTY: Lamb (Blind Hollow), June 11, 1963, Evers, Stannard, on wild hydrangea, 2 ♀. MONROE COUNTY: Valmeyer, July 19, 1948, Smith, Stannard, sweeping in woods, 1 ♀.

***Thrips tabaci* Lindeman** Onion thrips

Thrips tabaci Lindeman (1888:61). ♀, ♂. Type-locality.—Bessarabia, U.S.S.R.

Thrips striatus Gillette (1893:13). ♀.

Type-locality.—Fort Collins, Colorado. Synonymized by Priesner (1925c).

Limothrips tritici Webster (1894:206). *Nomen nudum*. Synonymized by Priesner (1925c).

Thrips alii Sirrine and Lowe (1894:680) *nec* Beach, *nec* Gillette. ♀, ? ♂. Type-locality.—Long Island, New York. Probably described from a series of mixed species, no types known to be in existence. Synonymized by Priesner (1925c).

Thrips communis Uzel (1895:176). ♀, ♂. Type-locality.—Probably Czechoslovakia. Synonymized by Priesner (1925c).

Parathrips uzeli Karny (1907:48). ♀. Type-locality.—Kotor, Yugoslavia. Synonymized by Priesner (1925c).

Thrips bicolor Karny (1907:49). ? ♀. Type-locality.—Kotor, Yugoslavia. Synonymized by Priesner (1925c).

Thrips solanaceorum John (1921:10) *nec* Widgalm. ♀. Type-locality.—St. Petersburg (Leningrad), U.S.S.R. Valid name by reference to *Thrips communis* Uzel. Synonymized by Priesner (1925c).

FEMALE (macropterous).—Length distended about 1.2 mm. General color yellow except blotches on thorax and median portions of most of the abdominal tergites which are light brown or entirely yellowish brown to gray brown. Antennal segment I light brown, remainder of antennae brown except bases of segments III–V which are somewhat paler. Fore wings pale gray. Ocellar pigment gray to yellowish gray. Body setae brown.

Head moderate in size.

Prothorax heavily setose but with small bare areas on either side of center posteriorly. Anterior margin of prothorax with no setae longer or stouter than the others. Inner posterior pair of major setae short, much shorter than dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs of setae. Fore wings usually with four or more apical bristles on fore vein, basal setae on fore vein short.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal

tergite VIII with a complete comb of long setae on posterior margin.

MALE (macropterous).—Not yet found in Illinois, nor represented in the collections of the Illinois Natural History Survey. According to Speyer (1934), male similar to female except smaller and lighter in color, and without a complete comb of setae on posterior margin of abdominal tergite VIII. Abdominal sternal glandular areas as a narrow transverse band on sternites III–V only.

This species is easily recognized by the gray or yellowish gray (instead of red) ocellar pigment, by the possession of four or more (instead of three or fewer) apical bristles on the fore vein of the fore wing, and by the limitation of the male glandular areas to segments III–V only.

Ghabn (1948) has given an excellent summary of the biology of *Thrips tabaci* as it occurs in Egypt and elsewhere. He quotes others as stating that the ratio of males to females is 1:3,000; one thysanopterist (see Sakimura) gives a ratio of 1:4. The low incidence of males in this species probably accounts for our failure to collect them in Illinois. Because, as Sakimura (1937) indicates, *Thrips tabaci* may succumb at temperatures below the freezing mark, it is possible that *tabaci* does not overwinter in Illinois out-of-doors. Rather it may be that this species survives the winter primarily on stored onion sets in our area.

Apparently onions are the preferred hosts of *tabaci*, although it may feed on other plants. Plant viruses are transmitted by *tabaci* (Sakimura 1940), and because this thrips is a vector of disease, it also can be an important pest on tomatoes, pineapples, and other crops.

In moderate numbers *tabaci* is of benefit to onion growers when its feeding causes the onion leaves to drop prematurely, thus speeding up the "hardening" of onion sets (W. H. Luckmann, Illinois Natural History Survey, personal communication, 1959).

Illinois records.—Collected out-doors in spring and summer (in greenhouse during late fall and winter),

from one to several localities in the following counties: CALHOUN, CARROLL, CHAMPAIGN, CLARK, COOK, HARDIN, IROQUOIS, JO DAVIESS, KANKAKEE, LAKE, LEE, MADISON, MC-HENRY, MCLEAN, PEORIA, POPE, PUTLASKI, PUTNAM, SANGAMON, and SCHUYLER.

Thrips tripartitus Hood

Thrips tripartitus Hood (1940c:562).

♀, ♂. Type-locality.—Oswegatchie, New York.

FEMALE (macropterous).—Not yet found in Illinois, nor present in the collections of the Illinois Natural History Survey. Originally described as being similar to brachypterous form except more robust and with fully developed wings. Fore wings light brown becoming paler apically, with two apical setae on fore vein.

FEMALE (brachypterous).—Length distended about 1.4 mm. Bicolored brownish yellow and dark brown. Brownish yellow: head, thorax, abdominal segments I, IX, and X. Dark brown: abdominal segments II–VIII. Antennal segment I pale yellow; segments II and III yellow; segments IV–VI yellow to brownish yellow at base, brown apically; segment VII brown. Legs yellow. Ocellar pigment red.

Head elongate.

Prothorax sparsely setose, most of central area except on middle line bare. Inner posterior pair of major setae on prothorax moderate in length, nearly equal to dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs of setae. Wings reduced to small pads.

Abdominal tergite II with three pairs of setae on each lateral margin. Sternites without accessory setae. Intermediate abdominal tergites with faint indications of scallops along posterior margins. Abdominal tergite VIII with a complete comb of small setae on posterior margin.

MALE.—Not yet found in Illinois. Originally described from the brachypterous form. Reported to be similar to female in color. Abdominal

sternites III–VII described as each having a small transverse glandular area.

This distinctive bicolored species is known only from Volo Bog (a tamara-rack bog in northern Illinois) and the type locality in New York.

Illinois records.—LAKE COUNTY: Volo Bog, September 14, 1950, Richards, 4 ♀; Volo Bog, October 9, 1952, Ross, Stannard, 7 ♀.

Thrips varipes Hood

Thrips varipes Hood (1913b:161). ♀.

Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended over 1.5 mm. General color dark brown. Antennal segment III, apexes of tibiae, and all tarsi yellowish brown to yellow. Fore wings grayish brown, abruptly pale basally. Ocellar pigment red.

Head moderate in size. Antennal segment VI shorter than to as long as segment III (Fig. 68).

Prothorax moderately setose with bare areas either side of center. Inner posterior pair of major setae long, nearly $1\frac{1}{2}$ times as long as dorsal length of eye. Three pairs of setae on posterior margin of prothorax between the major pairs. Fore wings with three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Sternites without accessory setae. Abdominal tergite VIII without a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended nearly 1.2 mm. Similar to female in color except head, intermediate antennal segments, thorax, and legs lighter.

Similar to female in structure except more slender. Sternites III–VII each with a large elliptical glandular area. Abdominal tergite IX with four anterior and two posterior setae.

The preceding key should serve to distinguish this species from others in Illinois. In comparison with *fuscipennis*, *varipes* may be recognized by having only three setae on each side of abdominal tergite II, by having the

fore wings lighter at the base, by having, on the average, a proportionately shorter sixth antennal segment, and by its slightly longer posterior prothoracic setae. Our collection of the male sex is apparently the first.

This species inhabits *Clematis* flowers primarily. It may be widespread in the state, but so far it has been found mostly in our central counties.

Illinois records.—Collected during summer, from one to several localities in the following counties: CHAMPAIGN, FORD, IROQUOIS, LAWRENCE, LIVINGSTON, MACON, MASON, MERCER, PUTNAM, and VERMILION.

Thrips winnemanæ Hood

Thrips winnemanæ Hood (1913b:166).

♀. Type-locality.—Plummer's Island, Maryland.

FEMALE (macropterous).—Length distended about 1.3 mm. Color almost entirely yellow, with no brown or gray spots. Antennal segment I pale, nearly white; segment II yellow; segments III–V yellow in basal half, brown in apical half; segments VI and VII predominantly brown. Fore wings light grayish brown. Ocellar pigment red. All major body setae dark brown.

Head moderate in size. Antennal segment III slender.

Prothorax moderately setose with bare areas either side of center. Anterior margin of prothorax with a pair of well-developed setae. Inner posterior pair of major setae long, more than $1\frac{1}{4}$ times as long as dorsal length of eye. Fore wings with three apical bristles on fore vein.

Abdominal tergite II with three setae on each lateral margin. Abdominal sternites without accessory setae. Abdominal tergite VIII with a complete comb of setae on posterior margin.

MALE (macropterous).—Length distended about 0.9 mm. Similar to female in general color and structure. Abdominal tergite VIII with posterior comb of setae weaker than in female and often a few setae missing. Abdominal sternites III–VII each with a large elliptical glandular area, these areas wider than in *pectinatus*,

decidedly wider than the distance between the bases of the median pair of posterior sternal setae. Abdominal tergite IX with two anterior and four posterior setae.

Morphologically *winnemanae* is the American equivalent of the European *flavus*. Both are similarly colored yellow and they are quite alike structurally. Should *flavus* be introduced into Illinois (it was reported from New York by Hood in 1927) it can be distinguished from *winnemanae* by the setal pattern of the prothorax. *Thrips flavus* has no anterior setae that are heavier and longer than neighboring setae and it bears four setae on the lateral margins of abdominal tergite II. By contrast *winnemanae* has a pair of heavier, longer setae on the anterior margin of the prothorax, and only three pairs of setae in the lateral margins of abdominal tergite II.

In Illinois the species *pectinatus* also resembles *winnemanae*. *Thrips pectinatus* is nearly white in color, not nearly as yellow as *winnemanae*; the body setae and wings of *pectinatus* are much lighter than in *winnemanae*; and the males of each species have distinctively shaped abdominal sternal glandular areas. The glandular areas found on *pectinatus* are much smaller than those on *winnemanae*. From the macropiterous form of *nigropilosis*, *winnemanae* may be distinguished by the lack of dark coloring on the metanotum. *Thrips winnemanae* is not known to produce brachypterous forms as does *nigropilosus*.

Although undoubtedly a common eastern North American thrips, *winnemanae* is scarce in collections and has not been mentioned in the literature from any region other than the type locality, Maryland. Our Illinois records are many and indicate that the species occurs most commonly in the central and southern parts of the state. In addition we have collected it from Tennessee, Kansas, and Arkansas. We have found that it is most abundant as adults and larvae on coralberry (*Symphoricarpos*) which may be its principal host. In winter adults of *winnemanae* hibernate in the old on the forest floor.

Illinois records.—Collected every season of the year, from one to several localities in the following counties: ADAMS, CALHOUN, CHAMPAIGN, CUMBERLAND, EFFINGHAM, HAMILTON, HARDIN, IROQUOIS, JOHNSON, KANE, MACON, MACOUPIN, MARION, PERRY, PIKE, UNION, WABASH, and WILLIAMSON.

Zonothrips Priesner

Zonothrips Priesner (1926b:260).

Type-species by original designation.—*Zonothrips karnyi* Priesner.

Head wider than long, not at all prolonged in front of eyes (Fig. 142). Ocelli on slightly raised area. Antennae seven segmented, segment VI pedicellate. Sense cones on antennal segments III and IV forked. Mouth cones bluntly pointed. Maxillary palps three segmented.

Prothorax with one pair of moderately developed posterior setae (Fig. 142). Prothorax sculptured as in *Sericothrips*, predominantly with fine, closely spaced, transverse striae, and with blotch area. Mesospinasternum separated from metasternum by a suture. Fore wings narrow except at base, with two longitudinal veins; fore vein evenly set with setae; hind vein with several setae at apex only; fringe cilia wavy. Tarsi two segmented.

Abdominal segments I–VIII covered with microsetae except median region on dorsum bare for the most part. Abdominal sternites II–VII with major setae forward of posterior margin, abdominal sternites without accessory setae except for microsetae. Abdominal tergites with median setae closely spaced. Abdominal tergites VI–VIII each with a complete comb of setae on posterior margin. Females with well-developed ovipositor. Males seemingly without abdominal sternal glandular areas, without thornlike setae.

This genus is like *Sericothrips* in all respects except in the number of antennal segments and the placement of the abdominal sternal setae. In *Zonothrips* each antenna is seven segmented and the major setae of abdominal

sternites II-VII are forward of the posterior margin. In *Sericothrips* each antenna is eight segmented and the major setae of abdominal sternites II-VI (not VII) are along the posterior margin, not forward of it. There are, therefore, definite characteristics that will allow the two genera to be kept as separate entities.

The sole New World species occurs in Illinois.

***Zonothrips osmundae* Crawford, J. C.**

Zonothrips osmundae Crawford, J. C. (1941a:105). ♀, ♂. Type-locality. —Tenafly, New Jersey.

FEMALE (macropterous).—Length distended over 1 mm. General color light orange-yellow with brown markings. Antennal segment I nearly colorless; segments II and III yellow; segments IV and V yellow in basal half, brown in apical half; segments VI and VII brown. Metascutum brown. Abdominal tergites I-VII with brown patches at sides and with brown anterior marginal line, segment II the darkest. Fore wings with two brown crossbands and with scale brown. Ocellar pigment red.

Antennal segments not particularly elongate.

Pronotal striae moderately close together (Fig. 142).

MALE (macropterous).—Length distended over 0.9 mm. Similar to female in general structure and color except brown patches slightly lighter on abdomen. Posterior comb of setae sometimes interrupted on abdominal tergites VI and VII.

This species differs from *karnyi* of Java, the only other known species, in being lighter in color and in not having the antennal segments elongate.

Zonothrips osmundae is confined to the northern part of Illinois where it is found on and around cinnamon fern.

Illinois records.—LAKE COUNTY: Volo Bog, September 14, 1950, Richards, 6 ♀; Volo Bog, October 15, 1952, McAlpine, 2 ♀, 1 ♂; Volo Bog, September 12, 1951, Richards, Stannard, 3 ♀; Volo Bog, October 9, 1952, Ross, Stannard, 1 ♂.

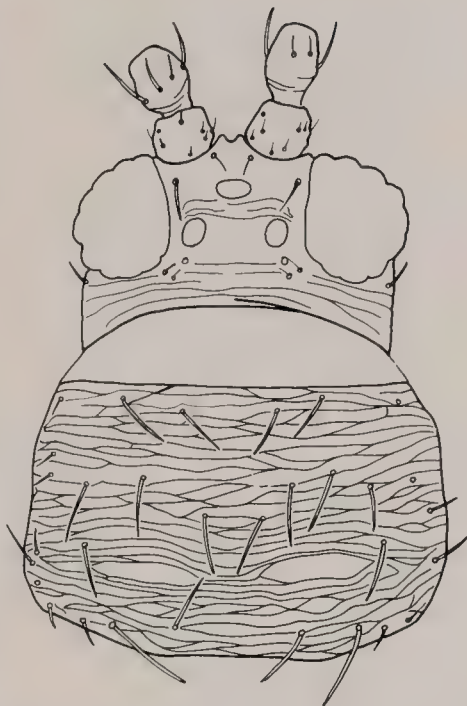


Fig. 142.—*Zonothrips osmundae*, head and prothorax.

Suborder TUBULIFERA

Antennae four to eight segmented, with sensoria, when present, setae-like on intermediate segments. Postocular setae usually well developed. Maxillary stylets (Fig. 143, s) often retracted well into the head, sometimes retracted up to the position of the eyes. Maxillary palps always two segmented although segment I sometimes minute.

Prothoracic notum ordinarily with epimeral sutures. Praepectal plates (Fig. 146, PP) frequently present. Mesopraesternum (Fig. 148) usually present. Mesospinasternum always fused to metasternum. Tarsi with each fore pair always one segmented (Fig. 183-185), each mid and hind pair one or two segmented. Wings, when developed, without longitudinal veins, without microsetae, with fringe cilia always straight, crossed when in repose over abdomen.

Abdominal tergite I with pelta (Fig. 150, PEL) usually closely joined

to tergite II, without stippled membranous posterior border. Abdominal segments without pleural plates, often with dorsal sigmoidal wing-holding se-

tae. Females with a fustis (Fig. 53, F), without sawlike ovipositor. Males often with sternal glandular-like area, tube incised at base on the sternum.

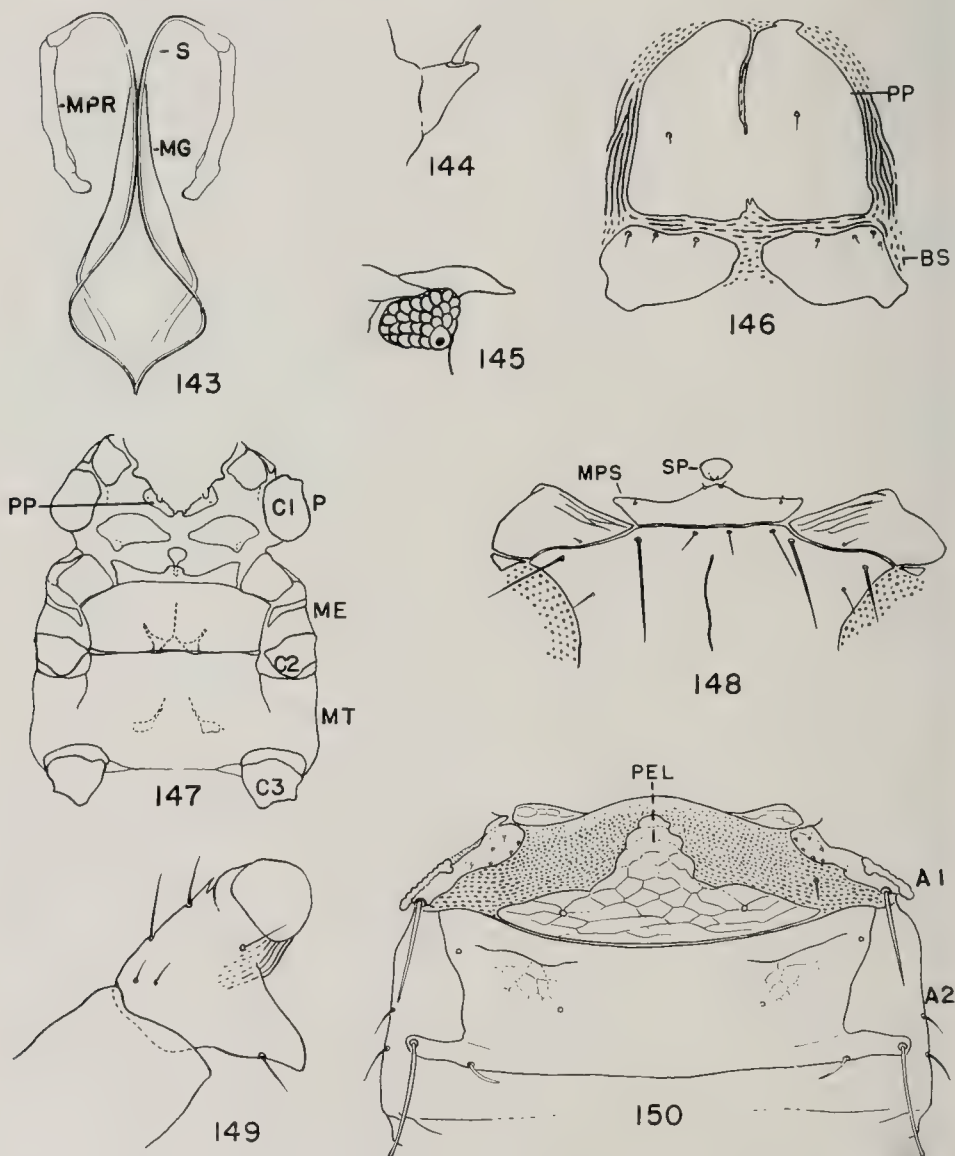


Fig. 143-150.—Characteristics of the Tubulifera: 143, typical maxillary stylets and guides, MPR—maxillary pillar, S—maxillary stylet, MG—maxillary guide; 144, seta-bearing cheek wart typical of some Phlaeothripidae; 145, spur anterior to mesothoracic spiracle of *Illinothrrips rossi*, ♂; 146, median part of prosternum of *Podothrips semiflavus*, PP—praepectus, BS—probasisternum; 147, ventral aspect of thorax of a species of *Sophiothrrips*, PP—praepectus, P—prosternum, ME—mesosternum, MT—metasternum, C—coxa; 148, ventral aspect of mesopraesternum of *Illinothrrips rossi*, SP—prospinasternum, MPS—mesopraesternum; 149, fore tarsus of *Allothrrips megacephalus* showing tooth-like projection; 150, orientation of pelta of *Plectrothrrips antennatus*, PEL—pelta, A—abdominal tergite.

Abdominal tergite X tubular (Fig. 186-191). Major anal setae arising from sclerites separated from abdominal segment X.

Three pupal instars present in those species where life history is known.

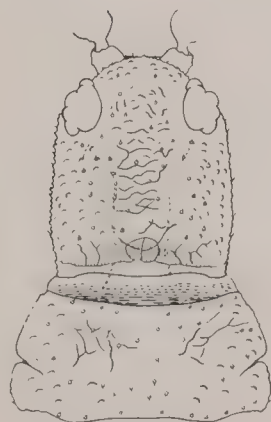
Contains the single family Phlaeothripidae, which is divisible into two subfamilies, Phlaeothripinae and Megathripinae.

Apparently Bagnall (1908*b*) was the first to separate the Tubulifera into two groups, the Phlaeothripidae and the Idolothripidae. In many respects these divisions are the same as the Phlaeothripinae and Megathripinae used here. Further additions to and other subdivisions of the Tubulifera were made in the next few years following Bagnall's proposal. In 1915 Hood added Pygothripidae to the list which by then also included Hystricothripidae, Megathripidae, and Urothripidae. Simplification of the system came about in 1927 when Priesner reduced the main division to the Phlaeothripinae and Megathripinae. Except for occasional shifts of genera from one tribe to another as more information is discovered to warrant the transfer, these two divisions seem phylogenetically proper for the initial grouping of the genera of Tubulifera (Stannard 1957*b*). Priesner (1960) recognized the Urothripinae as the third subfamily in his system, an action not followed in this report.

PHLAEOTHIRIPIDAE Uzel (1895)

KEY TO GENERA (ILLINOIS, EXCEPT WHERE NOTED)

1. Hind coxae spaced farther from each other than are the middle coxae. 2
- Hind coxae closer together than are the middle coxae. 3
2. Head without prominent anterior setae (Fig. 151). **Amphibolothrips** subgenus **Trachythrips**
- Head with one, two, or three pairs of prominent setae along the anterior margin between the eyes (Fig. 152); not yet found in Illinois. **Amphibolothrips** subgenus **Stephanothrips**
3. Prothorax with anteromarginal and anterolateral setae placed extremely close together (Fig. 277); antennal segment III small, goblet-shaped; antennal segment IV globular, largest segment; slender, tiny thrips. **Preeriella**
- Prothorax with anteromarginal and anterolateral setae placed farther apart; various sized thrips. 4
4. Maxillary stylets extremely long, each stylet looped several times within the head and mouth cone (Fig. 175); not yet found in Illinois. **Docessissophothrips**
- Maxillary stylets not as long; each stylet never looped more than once, if at all, within the head or mouth cone. 5
5. Prothorax with notum reduced to a well-defined, symmetrical, median shield bordered by minute sclerotized platelets (Fig. 266). **Plectrothrips**
- Prothorax with notum entire or, at the most, only slightly reduced laterally. 6
6. Pterothorax narrowest portion of body; metanotum raised, generally with striae arranged as concentric, anastomosing rings; antlike in appearance (Fig. 305). **Oedaleothrips**
- Pterothorax rarely narrowest portion of



Amphibolothrips
(Trachythrips) watsoni
151



Amphibolothrips
(Stephanothrips) bradleyi
152

Fig. 151-152.—Head and prothorax: 151, *Amphibolothrips* (*Trachythrips*) *watsoni*; 152, *Amphibolothrips* (*Stephanothrips*) *bradleyi* cf. California and Mexico.

body, often wide; metanotum not particularly raised, with striae usually linear or hexagonal in form; not antlike in appearance.....7

7. Abdomen with wing-holding setae expanded, leaflike; cheeks expanded later-

ally much beyond eye margins (Fig. 263).....**Neurothrips**

Abdomen with wing-holding setae, when present, slender; cheeks at the most only slightly expanded.....8

8. Eyes touching or nearly touching on dor-

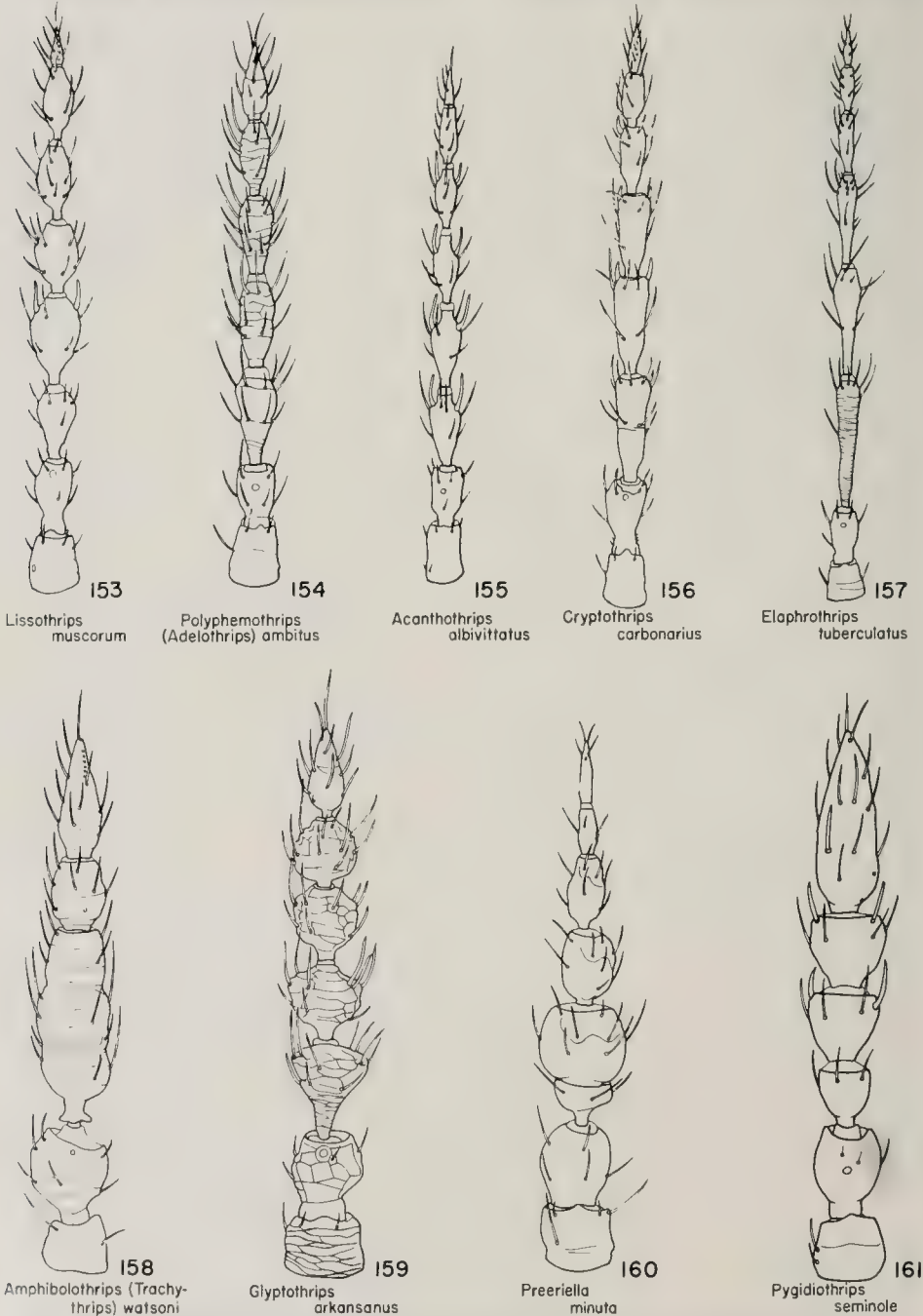


Fig. 153- 161. — Right antenna of species indicated, representatives of the Phlaeothripidae.

- sum of head; not yet found in Illinois.
.....**Macrophthalmothrips**
Eyes not touching, placed farther apart
on dorsum of head.....9
9. Antennal segment I bearing an extremely
well-differentiated, long, dorsal seta
which is dilated at tip (Fig. 179);
known from Florida only. **Atractothrips**
Antennal segment I usually without any
single outstanding seta (Fig. 153-161),
usually pointed, if dilated then setae
short and several such setae present. 10
10. Posterior margin of abdominal sternite
VIII with several long finger-like pro-
jections (Fig. 162); not yet found in
Illinois.**Chirothripoides**
Posterior margin of abdominal sternite
VIII straight.11
11. Many of the body and wing setae in-
verted L-shaped (Fig. 2); morpholog-
ical segments III and IV of the antenna
often fused; not known north of south-
ern Florida.**Hydiothrips**
Body and wing setae pointed, clubbed at
tip, or funnel-like, never inverted L-
shaped; morphological segments III
and IV of the antenna never fused. . 12

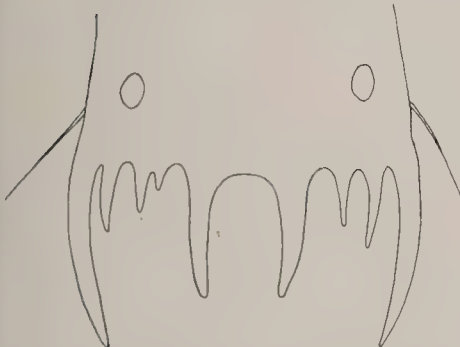
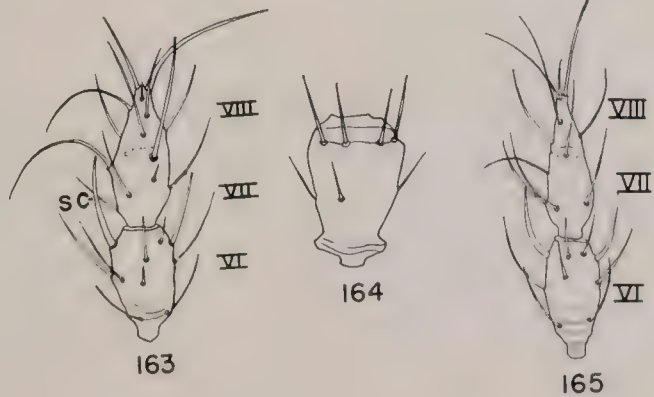
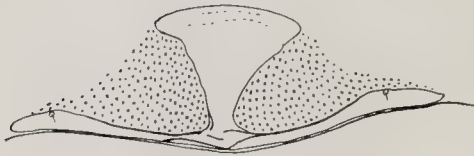


Fig. 162.—*Chirothripoides dendropogonus*, ♀, posterior margin of abdominal sternite VIII showing fingerlike projections. Redrawn from unpublished sketch made from holotype by Miss Kellie O'Neill.

Fig. 163-165.—Types of antennal segments: 163, terminal segments of *Polyphemothrips (Adelothrips) bradleyi*, showing partial fusion of segments VII and VIII, SC—sense cone; 164, antennal segment III of *Agrothrips tantillus* of Kansas, showing shelf-like rim near base; 165, terminal segments of *Polyphemothrips (Adelothrips) ambitus* showing close union of segments VII and VIII.



12. Antennae six segmented, terminal seg-
ment broad and long, formed by union
of morphological segments VI-VIII
(Fig. 161); known from southern Flori-
da to southeast Texas.
.....**Pygidiothrips**
Antennae seven or eight segmented...13
13. Antennae seven segmented, that is, last
two morphological segments partially
or completely fused (Fig. 163).....14
Antennae eight segmented, last two mor-
phological segments completely sepa-
rated by a continuous broad or fine
suture, segment VIII often freely mov-
able.24
14. Antennal segment II with dorsal sensori-
um placed near the middle of that seg-
ment; not yet found in Illinois.
.....**Williamsiella**
Antennal segment II with dorsal sensori-
um placed near the apex of that seg-
ment.15
15. Antennal segment III decidedly smaller
than segments II and IV separately
.....North
American species of **Phthirothrips**
Antennal segment III subequal to or
longer than segments II and IV sepa-
rately.16
16. Maxillary stylets when at rest just barely
retracted into the head capsule (Fig.
279 and 282).....17
Maxillary stylets when at rest retracted
far into the head capsule.....18
17. Pelta with posterior portion uniformly
sclerotized, not broken into tiny plate-
lets (Fig. 166 and 167).....
.....(in part) **Sophiothrips**
Pelta with posterior portion fractured
into tiny sclerotized platelets (Fig. 168)
.....(in part) **Zaxenothrips**
18. Cheeks with a close series of strongly de-
veloped warts along margin; epimeral
setae and lateral setae of abdomen
greatly expanded at tip; similar in over-
all appearance to *Amphibolothrips* and
subgenera; not known north of south-
ern Florida.
.....**Idiuthrips** subgenus **Strepterothrips**
Cheeks smooth or with marginal serr-
ations only moderately developed; epi-

*Sophiothrips bicolor*, macropterous

166

*Sophiothrips bicolor*, apterous

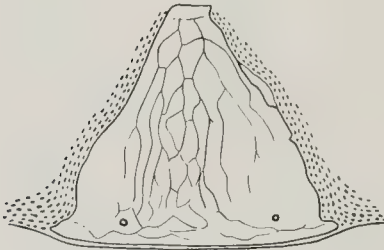
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*Zaxenothrips peculiaris*

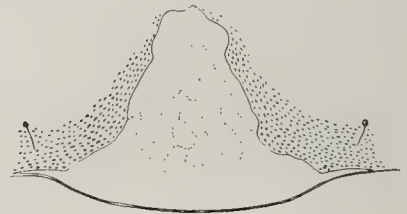
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*Lispothrips crassipes*

169

*Haplothrips (Leptothrips) mali*

170

*Polyphemothrips (Adelothrips) ambitus*

171

*Cryptothrips rectangularis*

172

*Illinothrips rossi*

173

Fig. 166-173. Types of peltas of species indicated, representatives of the Phlaeothripidae.

- meral setae pointed or at most knobbed, not greatly expanded. 19
19. Eyes moruloid, strongly bulged from head (Fig. 226) (in part) **Glyptothrips**
Eyes not especially in the shape of a morula, and not particularly bulging from head. 20
20. Eyes reduced to four to six facets; pelta large, although sometimes degenerate 21
Eyes larger, dorsally usually with 10 or more facets; pelta small or large; if eye with less than 10 facets, pelta always small. 22
21. Tube thick, ridged, longer than head. **Diopsothrips**
- Tube small, shorter than head. **Allothrips**
22. Epimeral sutures incomplete (Fig. 180). **Zaliothrips**
Epimeral sutures complete. 23
23. Abdominal tergites III-VIII each with a pair of black spots against the light background; color of remainder of the abdomen; tube as in Fig. 189; not yet found in Illinois. **Symphiothrips**
Abdominal tergites without paired black spots against a light background. (in part) **Polyphemothrips**
24. Fore wings banded by four light brown streaks; epimeral sutures completely lacking; pelta divided into three parts;

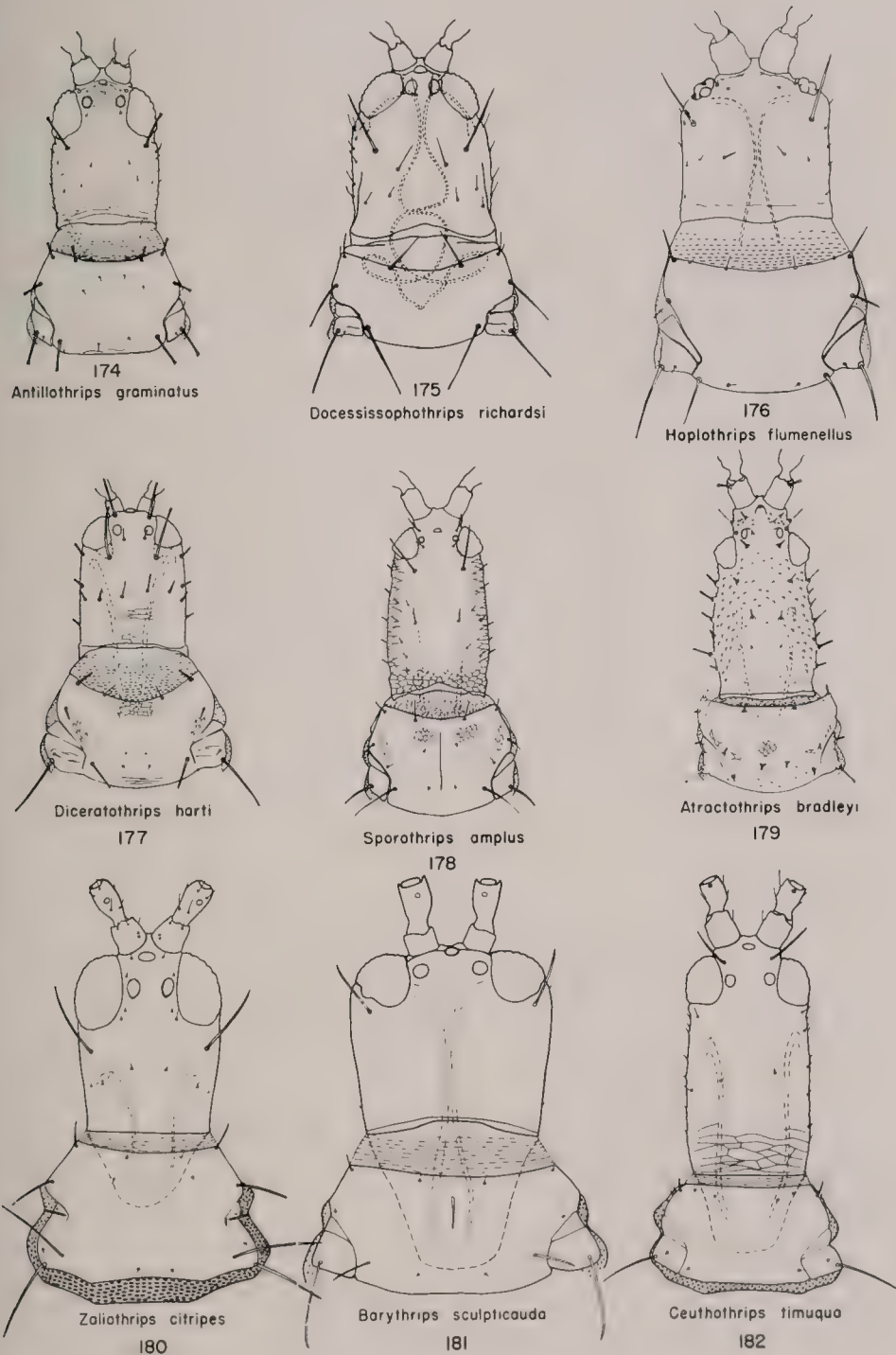
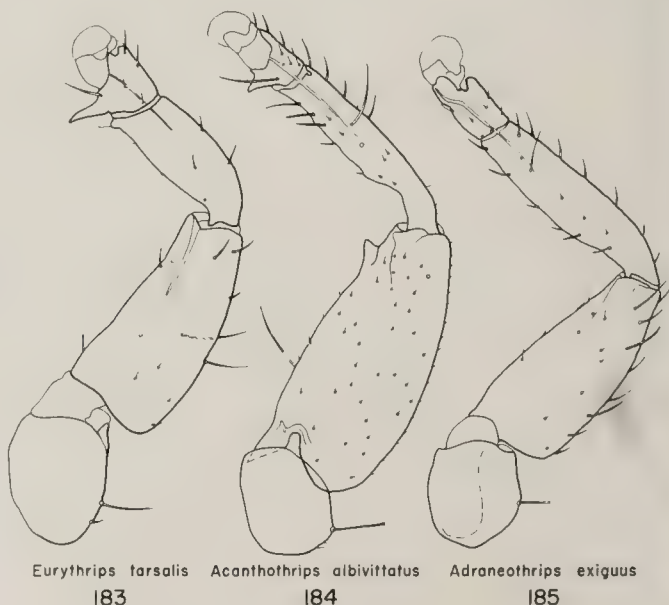


Fig. 174-182.—Head and prothorax of species indicated, representatives of the Phlaeothripidae.

- males with fore femora bearing a strong spur at the middle of the inner margin; not yet found in Illinois. **Aleurodothrips**
- Fore wings, when present, not banded by four streaks; epimeral sutures complete or incomplete; pelta often only a single shield; males with fore femora lacking inner, median spur, although spurs may be present apically or basally. .25
25. Maxillary stylets short, when at rest barely retracted into the head capsule (Fig. 174, 279, and 282). .26
- Maxillary stylets longer, when at rest retracted well into the head capsule. .28
26. Pelta with posterior portion fractured into tiny sclerotized platelets (Fig. 168) (in part) **Zaxenothrips**
- Pelta with posterior portion uniformly sclerotized, not broken into tiny platelets (Fig. 166 and 167). .27
27. Pelta much wider than long. (in part) **Sophiothrips**
- Pelta much longer than wide, more or less triangular in size; not known north of southern Florida. **Antillothrips**
28. Cheeks with enlarged, seta-bearing warts (Fig. 144). 29
- Cheek warts, if any, not bearing seta, usually of small size. 30
29. Antennal segments III and IV abruptly narrowed at apex, vase shaped (Fig. 155). most **Acanthothrips**
- Antennal segments III and IV gradually and slightly narrowed at apex; not yet found in Illinois. **Phlaeothrips**
30. Antennal segment III extremely small, decidedly smaller than either segment II or IV. **Lissothrips**
- Antennal segment III just slightly smaller, nearly equal to, or longer than segment IV. 31
31. Fore femora with subapical inner spurs (Fig. 184). 32
- Fore femora without subapical inner spurs, although spurs may be present in other positions. 34
32. Metanotum generally smooth or at most weakly sculptured; eyes smaller than length of antennal segments I and II combined. a few members of **flavicauda** group of **Hoplothrips**
- Metanotum strongly sculptured, usually with hexagonal reticulations; eyes usually as long as antennal segments I and II combined. 33
33. Head with a pair of proportionately larger setae near base of cheeks (Fig. 231). (in part) **Hoplandrothrips**
- Head without especially enlarged setae near base of cheeks (Fig. 205). some **Acanthothrips**
34. Lateral area adjacent to mesothoracic spiracle with spurlike process (Fig. 145). 35
- Lateral area adjacent to mesothoracic spiracle not produced into a process. 36
35. Head markedly elongate, eyes moruloid, bulged from side of head, not prolonged posteriorly on the venter of head. males of **Illinothrips**
- Head less elongate, eyes not particularly bulged, often prolonged posteriorly on the venter of head (Fig. 301). males of some **Nesothrips**
36. Prothoracic epimeral sclerites each bearing two strongly developed posterior setae. 37
- Prothoracic epimeral sclerites each bearing one well-developed and usually one minute seta. 39
37. Prothoracic epimeral sclerites each with three divisions. **Diphyothrips**

Fig. 183-185.—Right fore leg of species indicated, representatives of the Phlaeothripidae.



Eurythrips tarsalis

183

Acanthothrips albivittatus

184

Adraneothrips exiguus

185

- Prothoracic epimeral sclerites each consisting of the usual two divisions. . . 38
38. Antennal segments I and II each produced on inner ventral apex making these segments asymmetrical; not yet found in Illinois. **Acrosothrips**
Antennal segments I and II more or less symmetrical (Fig. 198)
39. Tube hairy with relatively long setae (Fig. 191); large black thrips. . . . 40
Tube not particularly hairy, setae relatively much shorter; thrips of various sizes and colors. 42
40. Maxillary stylets, when retracted, close together within head. . . . **Megalothrips**
Maxillary stylets, when retracted, far apart within head. 41
41. Antennal segment III longer than the combined length of segments I and II. **Megathrips**
Antennal segment III much shorter than

- the combined length of segments I and II; head and prothorax as in Fig. 182; known only from Florida. **Ceuthothrips**
42. Tube greatly swollen at base, parabolic in outline; not yet found in Illinois. **Pygothrips**
Tube cylindrical; if somewhat swollen at base, not parabolic in outline. . . . 43
43. Tube strongly hexagonally reticulate dorsally (Fig. 188); not yet found in Illinois. **Eschaethrips**
Tube with dorsum smooth or at the most weakly sculptured. 44
44. Fore wings with hexagonal reticulations on upper surface (Fig. 192b); not yet found in Illinois. **Stictothrips**
Fore wings without hexagonal reticulations, occasionally marked with short linelike sculpture but not forming geometric designs, or without wings. . . 45
45. Posterior margin of mesopraesternum not as wide as width of either anterior

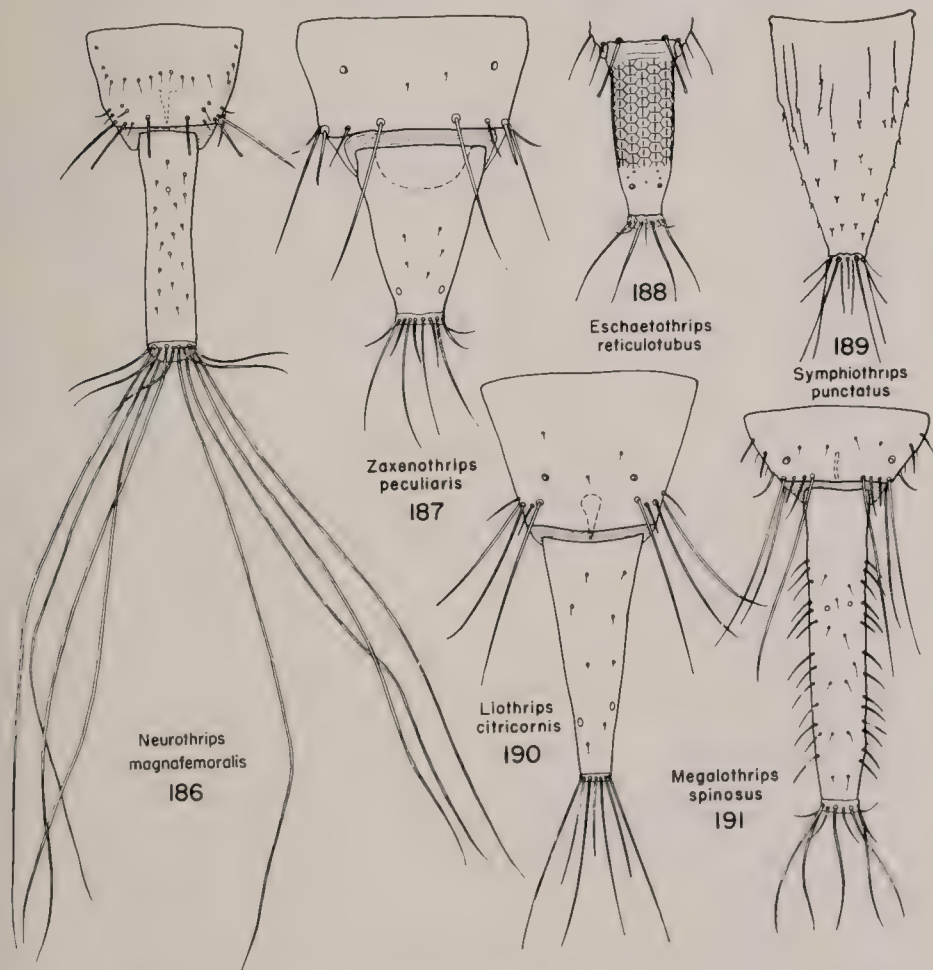


Fig. 186-191.—Abdominal terminalia of species indicated, representatives of the Phlaeothripidae showing types of tubes (abdominal segment X).

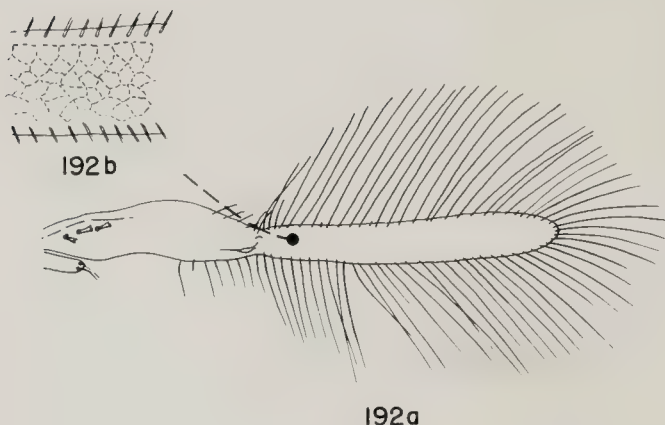


Fig. 192.—Fore wing of *Stictothrips maculatus*: a, entire wing; b, enlargement of center portion showing reticulations.

lateral margin of the mesoeusternum (Fig. 193); large thrips. . . *Elaphrothrips*
Mesopraesternum wider than the width of either anterior lateral margin of mesoeusternum (Fig. 194), or degenerate; large or small thrips. 46

46. Antennal segment III stocky, produced into a bulge or flange subbasally (Fig. 164). 47

Antennal segment III stocky or elongated, without a distinct bulge or flange subbasally. 48

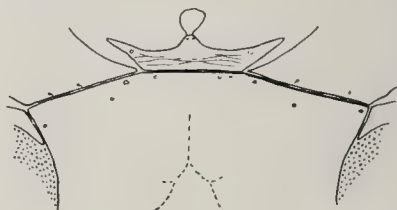
47. Maxillary stylets touching or nearly touching within the center of the head (based on an undescribed species). (in part) *Neothrips*

Maxillary stylets placed V-shaped within the head (Fig. 209). *Agrothrips*

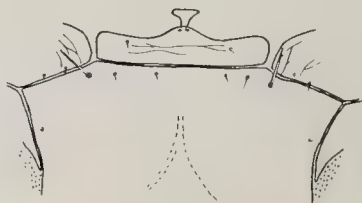
48. Mouth cone pointed, sometimes extremely long (Fig. 196). 49

Mouth cone more or less bluntly rounded (Fig. 197). 58

49. Maxillary stylets, when retracted, placed far apart within head. (in part) *Haplothrips*

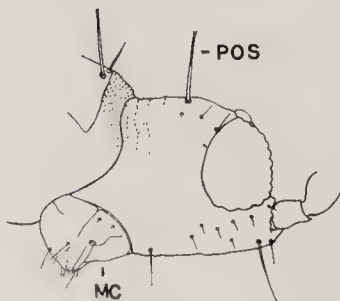


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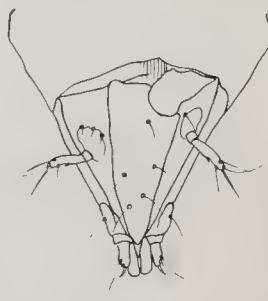


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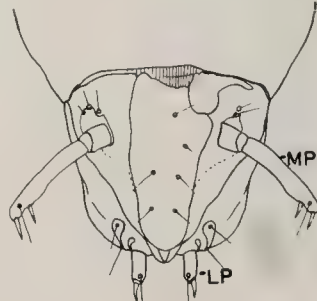
Fig. 193–194.—Mesopraesternum: 193, *Elaphrothrips flavipes*; 194, *Sporothrips amplas*.



195



196



197

Fig. 195–197.—Types of mouth cones: 195, position of mouth cone in *Preeriella minuta*, lateral, POS—postocular seta, MC—mouth cone; 196, pointed type of *Hoplothrips angustipes*; 197, broadly rounded type of *Polyphemothrips (Adelothrips) junctus*, MP—maxillary palps, LP—labial palps.

- Maxillary stylets, when retracted, placed fairly close together within head. 50
50. Eyes greatly reduced to a few dorsal facets (Fig. 237 and 262). 51
- Eyes normal in size (Fig. 267). 52
51. Antennal segments VII and VIII closely joined forming a compact unit. **Neothrips**
- Antennal segments VII and VIII well separated, each segment movable. (in part) **Haplothrips**
52. Mouth cone extremely long, extended beyond the posterior margin of the prothorax; postocular setae minute; eyes fairly close together on dorsum; not yet found in Illinois. **Poecilothrips**
- Mouth cone not as long, rarely extended to the posterior margin of the prothorax. 53
53. Pelta large (Fig. 169). **Lispthrips**
- Pelta smaller, generally triangular (Fig. 170). 54
54. Fustis of female large. (in part) **Haplothrips**
- Fustis of female small. 55
55. Head transversely striate. **Liothrips**
- Head smooth or with weak or strong hexagonal reticulations. 56
56. Eyes smaller than combined length of antennal segments I and II (Fig. 237 and 238). (in part) **Hoplothrips**
- Eyes nearly equal to or larger than combined length of antennal segments I and II. 57
57. Cheeks particularly indented behind eyes (Fig. 258). **Malacothrips**
- Cheeks not especially indented behind eyes (Fig. 230). **Hoplandrothrips**
58. Head on the dorsum entirely covered with strongly sculptured hexagonal reticulations. 59
- Head smooth or transversely striate on the median portion of the dorsum. 61
59. Antennal segment VIII nonpedicellate, closely joined to VII. **Glyptothrips**
- Antennal segment VIII pedicellate. 60
60. Praepectus absent; all setae on antennal segments III and IV pointed as in Fig. 198. (in part) **Hoplandrothrips**
- Praepectus present; antennal segments III and IV each with setae which are dilated at tips (Fig. 199). **Erkosothrips**
61. Mesopraesternum degenerate, divided into parts; pronotum with anteromarginal and midlateral setae minute; fore wings broad, not indented in the middle; metanotum with fine, small reticulations medially; maxillary stylets slender; not yet found in Illinois. **Treherniella**
- Characteristics not in this combination. 62
62. Maxillary stylets, when retracted, touching or nearly touching within center of head. 63
- Maxillary stylets, when retracted, well separated, often far apart. 69
63. Pelta with median posterior region fractured into stipple-like platelets (Fig. 198). 64

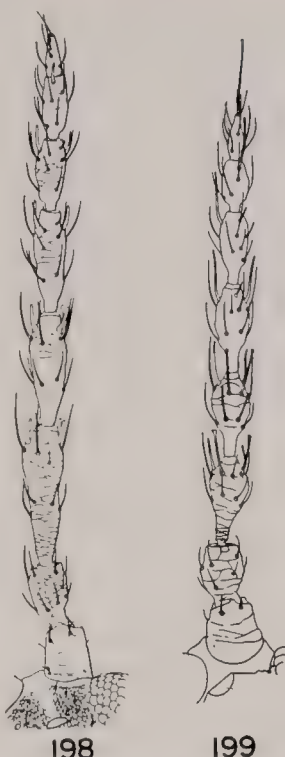


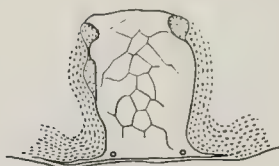
Fig. 198-199.—Right antenna: 198, *Acanthothrips vittatus*, from Hood (1933); 199, *Erkosothrips sculpturus*, from Hood (1936a).

- 200); head and prothorax as in Fig. 181; not yet found in Illinois.
- Barythrips**
- Pelta entire along posterior margin (Fig. 201) 64
64. Praepectus present; pelta wide; large, stout, black thrips. **Cryptothrips**
- Praepectus present or absent; pelta more or less triangular, not wide; usually smaller, often light brown thrips. 65
65. Maxillary stylets somewhat thickened; maxillary palps large, dorsal reticulations at base of head slightly upturned towards the meson before becoming obscure (Fig. 269-272). **Polyphemothrips**
- Maxillary stylets thinner; maxillary palps smaller; sculpture on dorsum of head either not reticulate or if reticulate, reticulations not noticeably upturned. 66
66. Pelta narrowed at base (Fig. 201) or divided into three parts. (in part) **Adranethrips**
- Pelta one unit, usually triangular to ovoid, not narrowed at base. 67
67. Eyes nearly as long as antennal segments I and II combined. **Gnophothrips**

- Eyes decidedly shorter than antennal segments I and II combined.....68
68. Praepectus present; epimeral sutures incomplete.....**Hindsiothrips**
Praepectus absent; epimeral sutures complete.....(in part) **Hoplothrips**
69. Praepectus very large, about three times as long as greatest length of probasisternum (Fig. 146); not yet found in Illinois.....**Podothrips**
Praepectus smaller, never more than twice as long as greatest length of probasisternum, or praepectus absent.....70
70. Maxillary stylets broad, bandlike, nearly the width of the labial palps; pelta usually wide.....71
Maxillary stylets slender, apex rarely as wide as one-half the width of the labial palps; pelta usually triangular.....74



200



201

Fig. 200-201.—Pelta: 200, *Barythrips sculpticauda*; 201, *Adraneothrips alternatus*. Neither of these species found in Illinois.

71. Eyes relatively small, bulged from head.....**Illinothrips**
Eyes often larger, not bulged from head.....72
72. Head usually long, parallel sided (Fig. 177); eyes never prolonged ventrally more than dorsally.....**Diceratothrips**
Head long or short, often slightly bulged along sides; eyes sometimes prolonged ventrally more than dorsally.....73
73. Eyes frequently prolonged ventrally more than dorsally; head not especially elongate (Fig. 301).....**Nesothrips**
Eyes never prolonged ventrally more than dorsally; head greatly elongate (Fig. 178); not yet found in Illinois.....**Sporothrips**
74. Eyes strongly bulged from head. (Compare also *Tylothrips* [Fig. 202]; not yet found in Illinois).....**Eurythrips**
Eyes not strongly bulged.....75
75. Eyes prolonged ventrally more than on dorsum.....76

- Eyes not prolonged ventrally more than on dorsum.....78
76. Antennal segment III elongate.....**Haplothrips (Leptothrips)**
Antennal segment III not particularly elongate.....77
77. Pelta moderately wide at base.....**Cephalothrips**
Pelta usually slightly constricted at base.....**Adraneothrips**
78. Prothorax with transverse sculpture forming several oval spots posteriorly; on *Ficus*.....**Gynaikothrips**
Prothorax with sculpture, if any, usually in the form of straight, transverse striae, or hexagonal reticulations....79

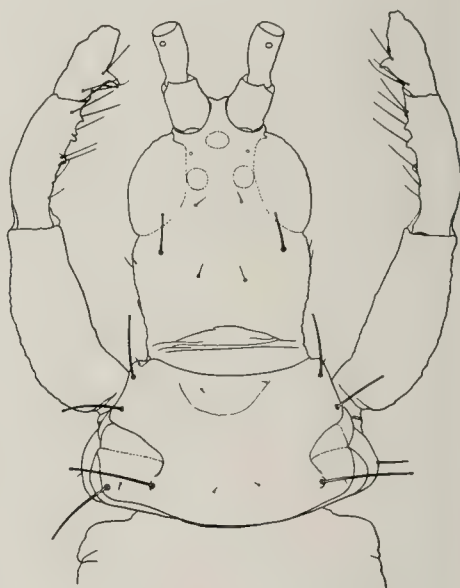


Fig. 202.—*Tylothrips bruesi*, head and prothorax. From Hood (1955).

79. Maxillary bridge strongly evident....80
Maxillary bridge apparently absent....82
80. Sculpture behind eyes often appearing somewhat as wrinkles; confined to under sheaths of *Yucca*.....**Bagnalliella**
Sculpture of head not usually appearing as wrinkles; not ordinarily on *Yucca*....81
81. Epimeral sutures complete..**Haplothrips**
Epimeral sutures incomplete.....(in part) **Hindsiothrips**
82. Eyes shorter than combined length of antennal segments I and II.....**Hoplothrips**
Eyes nearly equal to combined length of antennal segments I and II.....**Hoplandrothrips**

Subfamily PHLAEOTHIRIPINAE Karny 1921

This subfamily comprises those members of the Tubulifera that ordinarily have the maxillary stylets slender, whose males often have abdominal glandular areas, and whose males often have the lateral pair of major, posterior setae (setae II of authors) on abdominal tergite IX spine-like or shorter than in the female.

Acanthothrips Uzel

Acanthothrips Uzel (1895:259). Type-species by monotypy.—*Phloeothrips* [sic] *nodicornis* Reuter, O. M.

Notothrips Hood (1933:200). Type-species by original designation.—*Phlaeothrips vittatus* Hood. Synonymized by Stannard (1957b).

Head elongate, cheeks slightly expanded and often with prominent warts. Eyes large, bean shaped, not adjoining on the dorsum. Posterior cheek setae not proportionately larger than other cheek setae. Intermediate antennal segments vase shaped. Postocular setae well developed, rarely small. Mouth cone long and pointed. Slender maxillary stylets retracted far into head, touching within the center of the head.

Pronotum hexagonally reticulate or bearing small granules or stipple-like dots. Epimera each with one or two well-developed setae. Mesopraesternum well developed to slightly degenerate. Macropterous. Fore wings somewhat broadened, sometimes slightly indented in the middle, and with accessory fringe cilia present.

Abdomen generally reticulate. Pelta small, often trapezoidal. Abdominal tergites with two or three pairs of wing-holding setae, these setae not broad and flattened. Tube moderate in length, anal setae less than twice as long as tube.

This genus resembles *Neurothrips* and *Hoplandrothrips* in Illinois. Unlike *Acanthothrips* and *Hoplandrothrips*, *Neurothrips* has flat, enlarged, wing-holding setae and long anal setae

which are more than twice the length of the tube. *Hoplandrothrips*, in contrast to *Acanthothrips*, has a pair of prominent posterior cheek setae and by this characteristic these two usually may be distinguished. *Phlaeothrips*, which does not occur in Illinois, differs from *Acanthothrips* by lacking teeth on the fore femora or by having antennal segments III and IV each gradually (not abruptly) narrowed at the apex.

Only two species of *Acanthothrips* have been collected in Illinois to date.

KEY TO SPECIES (EASTERN UNITED STATES)

1. Head with large seta-bearing warts on cheeks; pronotum with only one pair of epimeral setae *nodicornis*
Head without large seta-bearing warts on cheeks; pronotum with two pairs of epimeral setae 2
2. Fore femora each armed with a subapical, inner spur; pronotum entirely granulate with stipple-like dots; major setae on posterior margin of abdominal tergite IX long and pointed
..... *albivittatus*
Fore femora each not armed with a spur; pronotum (Fig. 203) generally reticulate but with stipple-like dots superimposed; major setae on posterior margin of abdominal tergite IX relatively short and dilated at tips; not yet found in Illinois *vittatus*

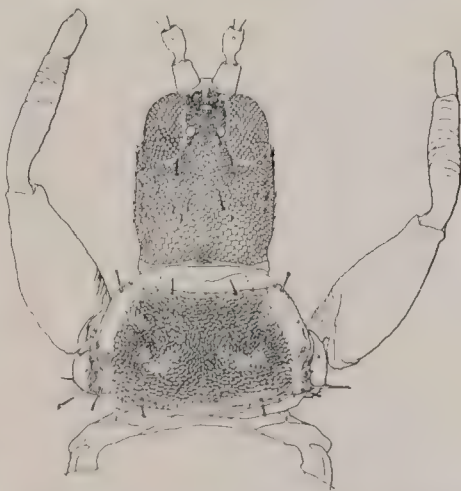


Fig. 203.— *Acanthothrips vittatus*, head and prothorax. From Hood (1933).

***Acanthothrips albivittatus* Hood**

Acanthothrips albivittatus Hood (1908c: 374). ♀. Type-locality.—Bloomington, Illinois.

FEMALE (macropterous).—Length distended nearly 3 mm. General color in life dark brown with a white strip on each lateral margin of the body extending from the posterior angle of the eyes to the anterior half of abdominal segment VIII but skipping abdominal segment I, and with a white half arc on the anterior part of the mesonotum. Body with much red subintegumental pigment.

Head reticulate, without enlarged cheek warts. Intermediate antennal segments vase shaped (Fig. 155). Postocular setae long and pointed.

Pronotum granulate, with many stipple-like dots. Epimera each with two well-developed setae which are dilated at tips. Meso- and metanotum with many stipple-like dots. Fore femora each enlarged and armed with an inner subapical spur. Fore tarsi each with a prominent tooth (Fig. 184). Fore wings with a light median streak.

Abdomen generally reticulate superimposed with stipple-like dots laterally. Pelta (Fig. 204) reticulate in the middle becoming granulate basally, bare laterally. Major posterior setae on abdominal tergite IX long and pointed.

MALE (macropterous).—Length distended about 2.7 mm. Similar to female in general color and structure. Abdominal sternite VIII with a narrow, median, transverse glandular area. Major posterior setae of abdominal tergite IX as in female, that is, all long and pointed.

Larvae.—Often with prominent head horns.

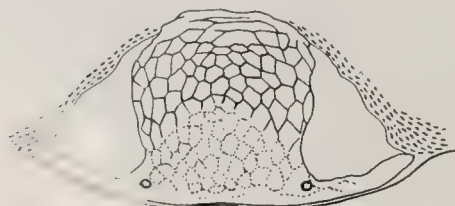


Fig. 204. *Acanthothrips albivittatus*, pelta.

This striking species can be recognized in life by the white lateral body stripes which extend onto the head up to the eyes. It is also easily distinguished by the characteristic of stipple-like markings on the prothorax. No other species in Illinois is so colored or sculptured.

A. albivittatus probably occurs throughout Illinois, on or under bark of dead trees, and is sometimes found in colonies. All specimens of this species that I have seen have been from the eastern half of the United States.

Illinois records.—**HARDIN COUNTY:** Karbers Ridge, May 4, 1950, Sander-son, Stannard, dead branches, 1 ♀, 2 ♂, 1 larva; Experimental Forest, August 17, 1951, Ross, Stannard, dead branches, 1 ♀. **HENDERSON COUNTY:** Oquawka, June 25, 1963, Braasch, Smith, Stannard, dead branches, 1 ♀, 1 ♂. **KANE COUNTY:** Carpentersville, September 26, 1956, Ross, Stannard, on dead oak, 5 ♀, 3 ♂, several larvae. **MCLEAN COUNTY:** Bloomington, July 10, 1908, Glasgow, on Carolina poplar, 1 ♀ (Hood 1908c). **PIKE COUNTY:** Kinderhook, September 9, 1954, Ross, Stannard, dead branches, 12 ♀, 5 ♂, 1 larva.

Acanthothrips nodicornis

Reuter, O. M.

Phloeothrips [sic] *nodicornis* Reuter, O. M. (1885:16). ? ♀. Type-locality.—?Finland. Placed in *Acanthothrips* by Uzel (1895).

Acanthothrips doaneii Moulton (1907: 64). ♂. Type-locality.—Alum Rock Canyon, California. Synonymized by Cott (1956).

Acanthothrips americanus Bagnall (1933:123). ♀, ♂. Type-locality.—Baldwin, Michigan. Synonymized by Hood (1938b).

FEMALE (macropterous).—Length distended nearly 4 mm. Generally dark brown in color. Yellow to yellowish brown: bases of intermediate antennal segments, fore tibiae largely, base and apex of mid and hind tibiae; and all tarsi. White dots on the lateral anterior margin of abdominal segments III–VIII (best seen in life). Body with much red subintegumental pigment.

Head (Fig. 205) reticulate, with many enlarged cheek warts. Intermediate antennal segments vase shaped. Postocular setae moderate in size.

Pronotum reticulate. Epimera each with one well-developed seta. Mesoscutum and metanotum reticulate. Fore femora enlarged and each armed with an inner subapical spur. Fore tarsi each with a prominent tooth. Fore wings evenly and moderately broad throughout.

Abdomen reticulate. Pelta completely reticulate. Major posterior setae on abdominal tergite IX moderate in size, slightly blunt at tips.

MALE (macropterous).—Length distended generally 2.5–3 mm. Similar to female in general color and structure. Abdominal sternite VIII with a narrow, median, transverse glandular area (Fig. 59).

Larvae.—Often with prominent head horns.

In Illinois this is the only species which has large cheek warts and white dots on the sides of the intermediate abdominal segments.

Acanthothrips nodicornis is widespread throughout Europe and northern North America. It may be native to Europe and introduced elsewhere. So far it has been found in Illinois only in the north, near Chicago. According to Yakhontov (1962) this species is apparently a predator.

Illinois records.—**COOK COUNTY:** Riverside, July, 1909, Hood, reared from pupae taken July 14, under bark on willow, became adult July 19, and reared from nymphs taken July 14, on willow bark, matured July 24, many ♀, ♂, (USNM-Hood collection); Western Springs, June 16, 1949, Ross, Stannard, on dead willow twigs, 3 ♀, 1 ♂, several larvae.

Acrosothrips Stannard

Acrosothrips Stannard (1963b:137).

Type-species by original designation.—*Trichothrips asymmetricus* Watson.

Head slightly longer than broad, nearly smooth. Eyes moderately small, shorter than the combined length of antennal segments I and II. Vertex broad at the apex between the antennae. Ocelli present, placed moderately far apart, fore ocellus not overhanging. Antennae eight segmented; segments I and II each produced on the inner ventral apex making these segments asymmetrical; segment III gradually tapered with one outer and no inner sense cone, segment IV with one inner and two outer sense cones, all of these cones short; intermediate segments moderately small; segment VIII slender, not broadly attached to segment VII. Postocular setae long. Maxillary stylets, when at rest position, retracted far into the head and placed fairly close together within the center of the head. Mouth cone moderately long, broadly rounded.

Prothorax not quite as long as head, nearly smooth. All major setae well developed, midlateral setae closer to epimeral setae than to anterolateral setae. Epimeral sutures complete. Each epimeron divided into two parts with two well-developed setae. Praepectus apparently absent. Metascutum faintly marked by longitudinal

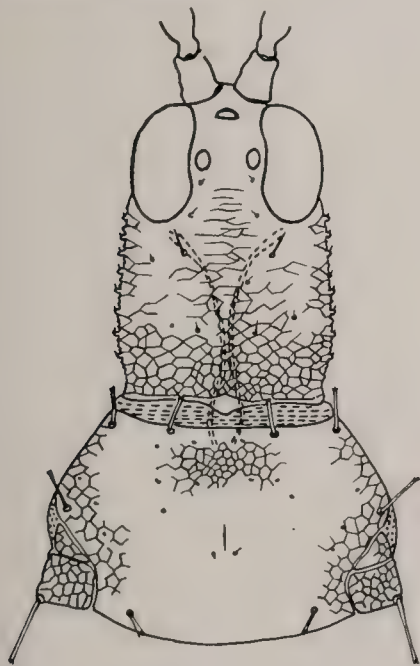


Fig. 205. *Acanthothrips nodicornis*, head and prothorax.

striations, without extremely long setae. Mesopraesternum completely separated by a suture from the mesosternum. Fore femora enlarged. Fore wings of even width throughout, without accessory fringe cilia.

Pelta small, bell shaped. Wing-holding setae relatively slender, sigmoidal. Abdominal tergite II at the extreme sides fractured into small stipple-like platelets. Abdominal tergite IX with major posterior setae much longer than tube. Tube shorter than head, about as long as prothorax; terminal setae shorter than tube.

The asymmetrical form of antennal segments I and II is diagnostic.

Aside from the characteristics of the antennae, which may or may not be only of specific value, this genus differs from *Hoplothrips* by the features of the two pairs of well-developed epimeral setae and the presence of lightly marked, longitudinal striations on the metascutum. Members of *Hoplothrips* have only one pair of well-developed epimeral setae and the metascutum is almost entirely smooth.

Phrasterothrips, an American genus which frequently is distinguished by the presence of two pairs of epimeral setae, differs from *Acrosothrips* by having the epimeral sutures incomplete, having the midlateral setae nearer the anterolateral setae on the prothorax, and having accessory cilia on the fore wings.

***Acrosothrips asymmetricus* (Watson)**

Trichothrips asymmetricus Watson (1937a:8). ♀, ♂, larva. Type-locality.—Birmingham, Alabama. Transferred to *Acrosothrips* by Stannard (1963b).

FEMALE (macropterous).—Length about 2 mm. Color brown. Antennal segments I and II light brown becoming light yellow at apices. Inner surfaces of legs and all tarsi yellowish brown to yellow. All body setae pale yellow. Wings colorless except light brown at extreme base of each fore wing.

Head as in Fig. 206. Postocular setae long and blunt. Ocellar setae minute. Antennal segment I asym-

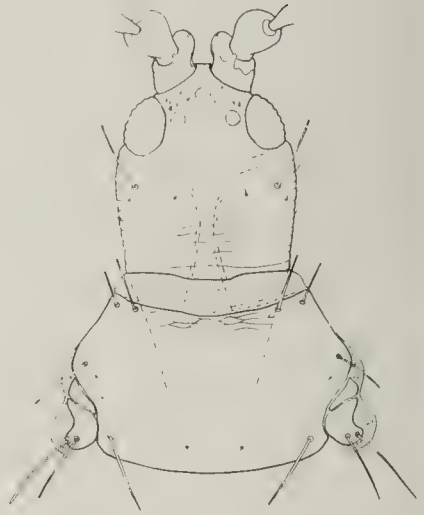


Fig. 206.—*Acrosothrips asymmetricus*, head and prothorax.

metrical, prolonged on the inner apical ventral portion; segment II asymmetrical, bulged on the inner apical portion; segment III gradually tapered from broad apex to narrow pedicel, with one outer sense cone which is about $19\ \mu$ long and with no inner sense cone; segment IV ovoid, pedicellate, with two outer sense cones of which the innermost one is $18\ \mu$ long, and the outermost one is $25\ \mu$ long, and with one inner sense cone which is about $23\ \mu$ long; segments V–VII moderate in size, pedicellate; segment VIII slender, parallel-sided basally, slightly tapered apically.

Prothorax (Fig. 206) with all major setae long and blunt at tips. Anteromarginal setae longer than anterolateral setae. Posteromarginal setae longest, just slightly longer than outer pair of epimeral setae, not as long as prothorax. Pterothorax with lateral-ventral setae pointed. Metascutum with posterior hexagonal reticulations oriented on a longitudinal axis occasionally forming anastomosing striae. Mesopraesternum entire. Fore tarsi unarmed.

Abdomen with pelta bell shaped, abruptly flanged near posterior margin. Lateral abdominal setae becoming progressively longer on each segment from II to IX, only lateral setae on

IX longer than tube. Abdominal tergite IX with all major setae pointed at tips.

This distinctive species, appropriately named by Watson in allusion to the asymmetrical form of antennal segments I and II, has not yet been found in Illinois. It is suspected to be in our state, however, because its supposed plant host, either *Ceanothus americanus* and/or *Tephrosia virginiana*, occurs in nearly every county.

Adraneothrips Hood

Adraneothrips Hood (1925d:54). Type-species by original designation.—*Haplothrips* (?) *tibialis* Hood.

Hypothrips Priesner (1933b:57). Type-species by original designation.—*Hypothrips desocellatus* Priesner. Synonymized by Stannard (1957b).

Head short to elongate, weakly sclerotized. Eyes prolonged (or not prolonged) posteriorly to form a pointed angle on the ventral surface of the head. Ocelli present in the macropterous form, absent in apterous form. Antennae eight segmented; segment VIII slender, conical. Mouth cone broadly rounded. Slender maxillary stylets retracted far into the head, either spaced fairly far apart and with a distinct maxillary bridge or nearly touching within the head and without a maxillary bridge.

Thorax weakly sclerotized. Pronotum usually with all major setae well developed. Epimeral sutures complete. Praepectus absent. Mesopraesternum degenerate. Fore wings, when present, indented in the middle, sparsely fringed and with or without a few accessory fringe cilia.

Pelta usually small in macropterous forms, somewhat larger in brachypterous and apterous forms. Anal setae usually much shorter than tube. Males usually with a glandular area on abdominal sternite VIII.

This genus is difficult to define when all of the species are considered. As represented by the single species, *exiguus*, in our state, *Adraneothrips* can be recognized by the nearly tripartite pelta (Fig. 208), the slender, conical shape of antennal segment

VIII, the absence of praepectal plates, and the sparse fringe cilia on the fore wings of the macropterous form. Some of these characteristics are not diagnostic when other faunas outside of Illinois are considered.

KEY TO SPECIES (EASTERN UNITED STATES)

1. Tube yellow; from Texas. **poecilnotus**
Tube brown. 2
2. Mouth cone long, more or less pointed, extended to or nearly to the posterior margin of the prothorax; from Florida. **rostratus**
Mouth cone shorter and broadly rounded. 3
3. Apterous or brachypterous. 4
Macropterous. 6
4. Abdomen predominantly yellow; from Kansas. **apalus**
Abdomen predominantly brown, or at least brown along the lateral margins. 5
5. Abdomen mostly brown; eastern United States. **exiguus**
Abdomen with median portions of tergites I–VI yellow to yellowish brown, lateral margins brown; from Florida. **stenocephalus**
6. Prothorax predominantly yellow. 7
Prothorax predominantly brown. 9
7. Body yellow except tube and antennae; body margined with yellowish orange subintegumental pigment; from Florida. **xanthosoma**
Body with brown on sides of head, at least; body margined with red subintegumental pigment. 8
8. Pterothorax and abdomen mostly yellow; male with abdominal sternite VIII bearing a barlike transverse glandular area; from Florida. **pallidus**
Pterothorax and sides of abdominal tergites III and IV light brown; male with abdominal sternite VIII bearing glandular area which is separated medially; from Cuba and Florida, north to Georgia, west to Texas and Mexico. **decorus**
9. Strongly bicolored. 10
Predominantly brown, not distinctly bicolored. 11
10. Head elongate, eye margin mostly on the anterior border of the head; from Florida. **cinctiventris**
Head shorter, eye margin continuing well onto the cheeks; from Florida, Puerto Rico, Mexico. **fuscicollis**
11. Eyes not much, if any, prolonged ventrally more than dorsally; abdominal sternite VIII of male with a large, oval, glandular area. 12
Eyes decidedly prolonged ventrally more than dorsally, abdominal sternite VIII of male with glandular area either unknown or small and often nearly circular in form. 13
12. Pelta with median portion broad; eastern United States. **exiguus**

- Pelta with median portion narrow; from Florida.....**pinicola**
 13. Fore wings without accessory cilia; tibiae, especially mid and hind tibiae, with brown on outer margin; from Florida.....**bellus**
 Fore wings with four accessory cilia, tibiae strongly yellow in contrast to dark femora; from Florida, Cuba, Puerto Rico, Peru, Brazil.....**tibialis**

***Adraneothrips exiguus* Hood**

Cryptothrips exiguus Hood (1912c: 154). ♀. Type-locality.—Grand Tower, Illinois. Transferred to *Adraneothrips* by Hood (1950a).

FEMALE (apterous) (Fig. 207).—Length distended about 1.5 mm. Bicolored dark brown and yellow varying to nearly entirely brown. Head dark brown at sides, brown at base, and yellow to brown between the eyes. Antennae brown except segment III and base of IV which are often yellowish brown to yellow. Prothorax and abdominal segments II–X dark brown becoming lighter brown in the basal segments. Pterothorax and abdominal segment I varying from nearly yellow to almost entirely brown. Legs except coxae yellow to yellowish brown, sometimes with femora and tibiae entirely brown. Body with much red subintegumental pigment.

Head elongate with a pair of light spots medially in the center of the dorsum. Eyes small, not prolonged ventrally. Ocelli absent. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones. Maxillary stylets placed close together within head. Mouth cone moderate in size.

Prothorax with all major setae present, subequal in length, and each dilated at tip. Epimeral sutures complete. Fore leg unarmed (Fig. 185).

Pelta usually separated into three parts, pores apparently absent (Fig. 208). Wing-holding setae reduced.

FEMALE (macropterous).—Length distended about 1.4 mm. Similar to apterous form except for the following differences. Head sometimes slightly shorter. Ocelli present. Fore wings present, without accessory fringe cilia. Abdominal tergites each with two pairs of sigmoidal wing-holding setae.

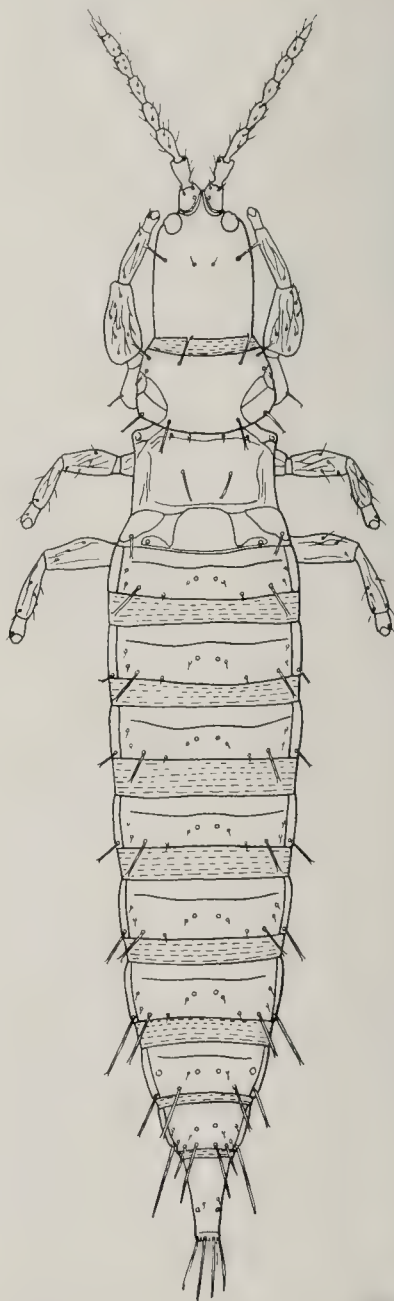


Fig. 207.—*Adraneothrips exiguus*, dorsal aspect.

MALE (apterous).—Length distended about 1.3 mm. Similar to apterous female except more slender. Abdominal sternite VIII with a medially placed oval glandular area (Fig. 58).

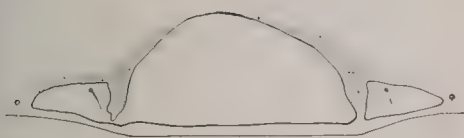


Fig. 208.—*Adraneothrips exiguus*, pelta.

The first concept of this species was based on a single macropterous female from southern Illinois. The illustration accompanying the original description (Hood 1912c) in which the prothorax is depicted as lacking the posteromarginal setae and having incomplete epimeral sutures is in error.

A close relative of *exiguus* appears to be the Floridian *stenocephalus*. *Adraneothrips stenocephalus* differs in having a slightly longer head, a slightly longer mouth cone, and by having two, instead of one, outer sense cones on antennal segment III. Also, in *stenocephalus*, the basal abdominal segments tend to be more yellow in color.

Adraneothrips exiguus, as determined here, occurs throughout Illinois, but in the north it may be confined to sand or gravel areas. Most of our specimens are of the light color phase. Specimens from Maryland, North Carolina, and Tennessee tend to be darker. Often this species is abundant in *Andropogon* clumps or in ground cover of pine plantations.

Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 9, 1951, Richards, Stannard, sod of *Andropogon*, 8 ♀, 8 ♂. HENDERSON COUNTY: Oquawka, May 9, 1952, Mills, Stannard, sod of *Andropogon*, 1 ♀, 4 ♂. JACKSON COUNTY: Grand Tower, July 12, 1909, Hart, sweeping, 1 ♀ (Holotype). KANE COUNTY: Elgin, October 10, 1952, Ross, Stannard, sod of *Andropogon*, 1 ♀. LAWRENCE COUNTY: Red Hills State Park, April 30, 1950, Smith, Stannard, sod of *Andropogon*, 1 ♂. POPE COUNTY: Glendale, November 7, 1946, Ross, Burks, pine debris, 1 ♀, 2 ♂. RICHLAND COUNTY: Olney, November 9, 1953, Smith, Stannard, sod of *Andropogon*, 1 ♂. WAYNE COUNTY: Zenith, May 7, 1966, Felix-Williams, sod of *Andropogon*, 1 ♀. WILLIAMSON COUN-

TY: Johnston City, November 19, 1959, Stannard, sod of *Andropogon*, 11 ♀.

Agrothrips Jacot-Guillarmod

Agrothrips Jacot-Guillarmod (1939: 40). Type-species by original designation.—*Agrothrips priesneri* Jacot-Guillarmod.

Head much longer than wide, smooth, just slightly constricted behind the eyes (Fig. 209). Eyes moderate in size, not prolonged posteriorly on the ventral surface more than on the dorsal surface. Ocelli present in Illinois forms. Postocular setae moderately developed, pointed to dilated. Antennae eight segmented; segment III swollen near the base into a shelf-like ring (Fig. 164), sense cones difficult to see; segment VIII broadly attached to segment VII. Mouth cone short, broadly rounded. Maxillary stylets when retracted form a V within the head. Maxillary bridge broad.

Prothorax smooth; Illinois species with only anterolateral and major posterior setae well developed, blunt to dilated; anteromarginal and midlateral setae minute except in *tenebricosus* which is not a member of our fauna.

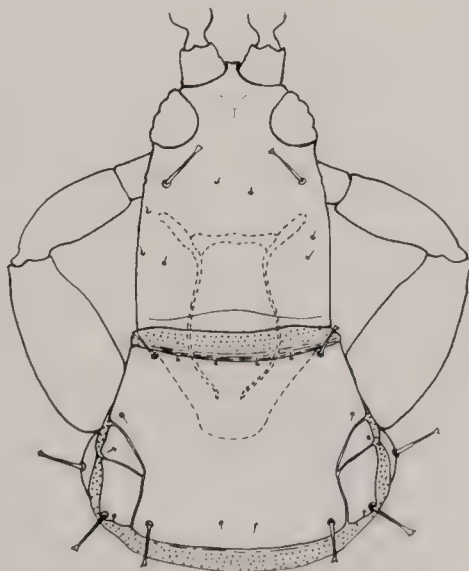


Fig. 209. *Agrothrips tantillus* of Kansas, head and prothorax.

Epimeral sutures complete. Praepectal plates present. Meso- and metanotum not fused in the Illinois species. Macropterous, brachypterous, or apterous. Fore wings when present narrowed beyond middle, with accessory fringe cilia. Fore tarsi unarmed or each armed with a small tooth.

Pelta usually in the form of a broad triangle, smooth. Abdominal tergite IX with major median posterior setae shorter than or longer than the tube. In males, abdominal sternite VIII with or without a differentiated glandular area, abdominal tergite IX with major lateral posterior setae reduced in size. Tube much shorter than head, not thickened or ridged.

Although similar in most respects to *Haplothrips* subgenus *Karnyothrips*, *Agrothrips* can be distinguished at once by the characteristic of the shelf-like ring near the base of antennal segment III. I have reviewed this genus elsewhere (Stannard 1958b).

Only one species, *omani*, occurs in Illinois. It may have been introduced from the southwest. Other species occur on the grasslands of western United States and Mexico, and in South Africa.

KEY TO SPECIES (OF NORTH AMERICA)

1. Antennae completely dark brown; midlateral prothoracic setae well developed; from Distrito Federal, Mexico. **tenebricosus**
Antennae with several segments yellow or yellowish brown; midlateral prothoracic setae minute. 2
2. Abdomen primarily light brown. 3
Abdomen generally yellow except most of tube which is brown. 5
3. Antennal segments I–VI bright yellow, segments VII and VIII brown; abdominal sternite VIII of male lacking glandular area; from Kansas to Texas. **dimidiatus**
Antennal segment II, at least, brown; abdominal sternite VIII of male with or without glandular area. 4
4. Antennal segments I, II, VII, and VIII brown, segments III–VI bright yellow; head brown; abdominal sternite VIII of male lacking glandular area; from Illinois to Arizona. **omani**
Antennal segments I and III yellow, remainder of antennae yellowish brown; head light yellowish brown; abdominal sternite VIII with a transverse glandular area; from Kansas to New Mexico. **tantillus**

5. Antennal segments I–III bright yellow, segments IV–VIII yellowish brown; abdominal sternite VIII with a transverse glandular area which is forked at both lateral extremities; from Arizona. **arenicola**

Antennal segments I–VI bright yellow, segments VII and VIII brown; abdominal sternite VIII of allotype male (because of differences in color with holotype female, whether the allotype is conspecific with the holotype should be further confirmed) with glandular area transverse linear, without forks; from Texas. **pallidus**

Agrothrips omani (Crawford, J. C.)

Haplothrips (Hadothrips) omani Crawford, J. C. (1947:250). ♀. Type locality.—Tucson, Arizona.

FEMALE (apterous).—Length of Illinois specimens distended about 2.1 mm (slightly larger in specimens known from southwestern United States). General color dark brown. Yellow: antennal segments III–VI except for light brown cloud at apex of segments IV–VI, apical portions of tibiae, and all tarsi. Tube darkest brown. Body with much red subintegumental pigment.

Head longer than wide, generally smooth. Ocelli present. Postocular setae pointed to blunt. Antennal segments VI and VII with distinct pedicels. Maxillary bridge considerably forward of posterior margin of the head.

Prothorax with those major setae that are well developed blunt to slightly dilated. Metanotum nearly smooth. Wings and wing pads lacking; notum of thorax not degenerate as is typical of some apterous specimens in other species. Fore tarsi each armed with a small tooth.

Pelta broadly triangular. Wing-holding setae not differentiated. Abdominal tergite IX with major posterior setae shorter than tube, pointed. Tube much shorter than head.

MALE (apterous).—Length distended over 1.6 mm. Similar to female in general color and structure. Abdominal sternite VIII without a differentiated glandular area. Abdominal tergite IX with major lateral posterior setae reduced in size.

This is the only species of *Tubuli-*

fera in Illinois which has antennal segment III swollen into a shelflike ring at the base—a principal characteristic of the genus.

First described from Arizona, *omani* has since been found in southeastern Colorado and Nebraska (INHS records) and Illinois (Stannard 1958b). Our only Illinois specimens came from pastures around Sheldon in Iroquois County. That these Sheldon populations may have been from introduced stock can be presumed because they were so far out of the range expected of a species from the southwestern part of the United States and because they were apparently confined to a single pastureland area that contains few, if any, native plants.

Aleurodothrips Franklin

Aleurodothrips Franklin (1909:228).

Type-species by monotypy.—*Cryptothrips fasciapennis* Franklin.

Microcanthothrips Bagnall (1914:295).

Type-species by original designation.—*Cephalothrips spinosus* Bagnall. Synonymized by Priesner (1949).

Head quadrate, about as long as wide, weakly striate, not projecting much beyond anterior eye margin. Ocelli present, fairly widely spaced, fore ocellus about on line with anterior eye margin. Eyes moderately large, not prolonged ventrally. Postocular setae small, pointed. Antennae eight segmented, inserted at the anterior margin of the head; segment II with dorsal sensorium placed apically; segments III and IV with short sense cones; segment VIII separate but closely joined to segment VII. Mouth cone short, broadly rounded. Maxillary stylets, when at rest, extended up to eyes, widely spaced within head.

Pronotum shorter than head, smooth except for posterior margin. Only anterolateral and epimeral setae well developed, these dilated. No trace of epimeral sutures. Praepectus present. Probasissternal plates large. Macropterous. Metascutum smooth. Mesospinasternum fully formed. Females with fore legs unarmed; males bearing a large toothlike projection on each of

the fore femora, three or four seta-bearing warts on each of the fore tibiae, and a moderate-sized tooth on each fore tarsus. Mid and hind femora without differentiated setae. All tarsi seemingly one segmented. Fore wings slightly narrowed in the middle, lacking accessory cilia.

Pelta divided into three parts. Abdominal tergites II–IV more or less with anastomosing, transverse striae, tergites V–VII more or less hexagonally reticulate, tergites VIII and IX nearly smooth. Abdominal tergites II–VII each with one pair of sigmoidal wing-holding setae; lateral setae dilated. Males with abdominal sternite V with several pairs of differentiated median setae, abdominal sternite VIII with glandular area. Abdominal tergite IX with major dorsal, posterior setae shorter than tube, dilated; lateral pair in male as long as in female, not shorter as in males of many species in the Phlaeothripinae. Tube much shorter than head, terminal setae shorter than tube.

Aleurodothrips is distinctive by the combination of a) the lack of epimeral sutures on the pronotum and b) the division of the pelta into three parts. The armature of the fore femur of the male is also diagnostic.

Probably this genus is monobasic. According to my analysis *Chromatothrips* Schmutz is a good genus and not a synonym of *Aleurodothrips* as supposed by Bagnall (1915b).

Aleurodothrips fasciapennis (Franklin)

Cryptothrips fasciapennis Franklin (1908:727). ♀. Type-locality.

Glendor, St. Michael, Barbados Islands. Franklin (1909:230). ♂. Transferred to *Aleurodothrips* by Franklin (1909).

Cephalothrips spinosus Bagnall (1909a:174). ♂. Type-locality.—Brussels Botanical Gardens, Belgium. Transferred to *Microcanthothrips* by Bagnall (1914). Synonymized by Priesner (1949).

FEMALE (macropterous) (Fig. 210). Length distended about 1.8 mm. Bicolored brown and yellow. Brown:

head, except yellow anteriorly; prothorax, posterior line on mesoscutum; sides of abdominal tergite I, anterior lateral stripes on tergites II-IV, all of tergites V and VI (which are the darkest), most of VII except lighter posteriorly, basal two-thirds of tube; fore femora and inner apical portions

of mid and hind femora; antennal segments IV and V at extreme apex, VI except extreme base, and all of segments VII and VIII. Fore wings pale, banded with light brown at bulge near base, medially, and at apex. Major setae pale yellow.

Head slightly wider than long, dor-

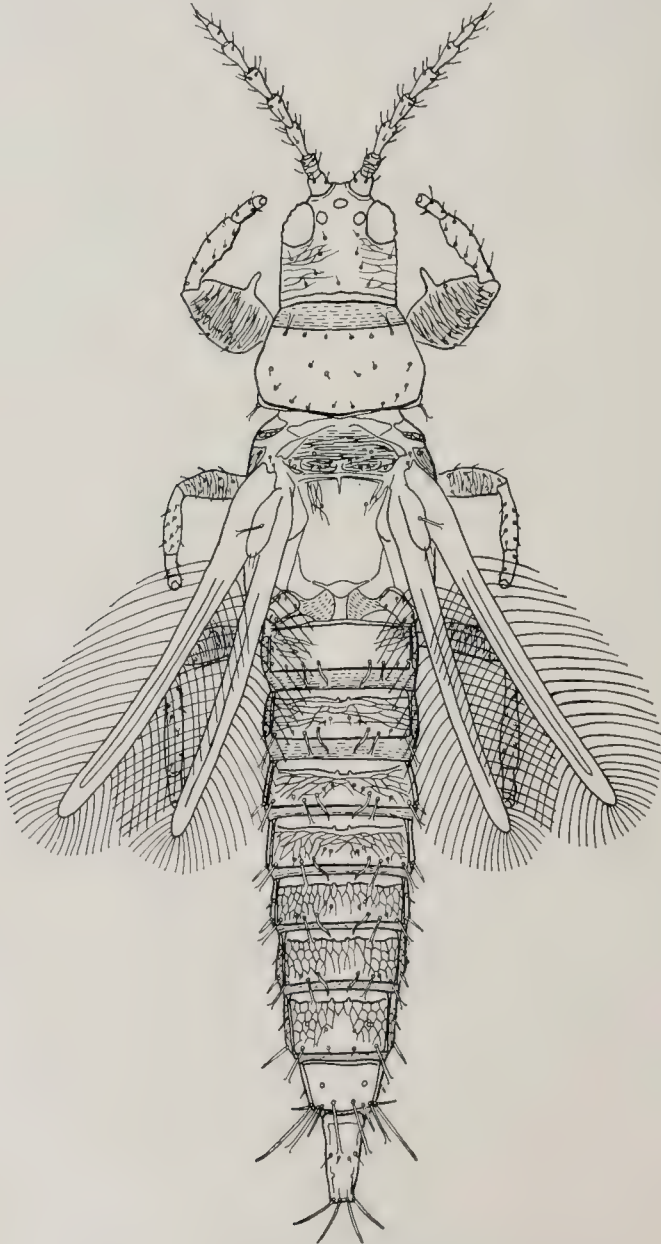


Fig. 210.—*Aleurodothrips fasciapennis*, dorsal aspect.

sal surface with several dozen small setae. Eyes not extended laterally more than cheeks. Postocular setae not distinguishable from other small setae. Vertex fairly wide. Mouth cone short, bluntly rounded. Maxillary stylets widely spaced. Maxillary bridge not discernible.

Antennal segments—I quadrate; II with broad pedicel, dorsal sensorium placed near apex; III subconical, pedicellate with no inner and one outer sense cone; IV subconical, with one inner and one outer sense cone; V and VI cylindrical, broadly pedicellate; VII cylindrical with a broadly flanged pedicel; VIII conical, not pedicellate.

Pronotum shorter than head, with only anterolateral and epimeral setae well developed, dilated. Epimeral sutures lacking. Praepectus present, closely placed under mouth cone.

Pterothorax longer and wider than pronotum. Metascutum smooth with small setae.

Legs with fore femora slightly enlarged, unarmed.

Fore wings outcurved at base, slightly constricted in middle, without accessory cilia.

Abdomen with pelta divided into three parts. All sternal setae slender. Tube weakly sculptured.

MALE (macropterous).—Length distended about 1.3 mm. Similar to female in color and structure except lighter yellow in abdomen, only segment VI dark brown; fore femora each with long inner, toothlike projection; fore tibiae each with several seta-bearing warts; fore tarsi each armed with a tooth; abdominal sternite V with three pairs of enlarged median setae; and lateroventral setae spinelike.

This species is easily distinguished by the characteristics of the genus. It is one of the few Tubulifera with brown-banded wings. Apparently it is a predacious thrips that feeds on scale insects, and presumably has become tropicopolitan through the agency of man.

Watson's description (1922a) of the male of *Karnyothrips weigeli* is based on a female of *Aleurodothrips fascica-*

pennis, the slide of which I examined in 1962 at the Watson Collection, Gainesville, Florida.

As yet this species has not been found in Illinois, but it might be expected in greenhouses, an artificial habitat where it is sometimes found in other states.

Amphibolothrips Buffa

This genus is represented in Illinois solely by the subgenus *Trachythrips*. The remaining subgenera were treated elsewhere (Stannard 1957b).

subgenus *Trachythrips* Hood

Trachythrips Hood (1929:317). Type-species by original designation.—*Trachythrips watsoni* Hood. Subordinated by Stannard (1952b).

Head longer than wide, entirely covered by warts, anterior of head without prominent setae. Eyes with a few large facets arranged in two short rows dorsally. Ocelli lacking. Postocular setae minute. Antennae five or six segmented. Mouth cone short, broadly rounded. Maxillary stylets retracted far into the head, parallel within the head.

Prothorax warty, with all setae minute. Epimeral sutures fused to pronotum. Praepectal plates present. Meso- and metanotum degenerate. Meso- and metasternum fused. All tarsi apparently one segmented. Hind coxae farther apart than are the middle coxae. Always apterous.

Pelta in the form of a continuous dorsal band (Fig. 213). Wing-holding setae not differentiated. Lateral abdominal setae short, thick, and blunt. Abdominal segment IX cylindrical, fustus extending the entire length of the segment. Tube long, with six extremely long terminal setae.

This taxon is distinct from all other genera in Illinois by the characteristics of the five-segmented antennae.

Only one species, *watsoni*, is known to be in our state. Other species occur in North and South America, particularly in the tropical regions.

**Amphibolothrips (Trachythrips)
watsoni Hood**

Trachythrips watsoni Hood (1929:317).
♀, ♂. Type-locality.—Villa Tasso,
Florida. Transferred to *Amphibolo-*
thrips by Stannard (1952b).

FEMALE (apterous) (Fig. 211).—Length distended about 1.4 mm. Bi-colored brown and yellow. Head, prothorax, mesothorax, fore legs, and tip of tube dark brown. Abdominal tergites II–VIII each with a pair of light brown dots, one on either side. Remainder of body yellow except the terminal antennal segment which is often yellowish brown. Head and thorax with red subintegumental pigment; abdomen with white subintegumental pigment, especially along the sides.

Head broadly rounded in front, not emarginate medially (Fig. 151). Eyes each with at least two rows of dorsal facets. Ocelli absent. Postocular setae minute. Antennae five segmented (Fig. 158), morphological segments III–V and segments VII and VIII completely fused.

Prothorax with all setae small. Fore tarsi each with a recurved claw (Fig. 212).

Pelta as in Fig. 213. Abdominal tergite IX slightly shorter than tube, all major posterior setae minute. Tube slender, generally straight sided.

MALE (apterous).—Length distended about 1 mm. Similar to female in general color and structure. Abdominal sternite VIII without glandular area. Abdominal segment IX and tube nearly equal in length.

This handsome, tiny thrips can be recognized by the characteristics of the subgenus. In our state it is abundant south of the Shelbyville moraine. Collections made after my article on its distribution in Illinois (1952a) have shown that its range extends northward up the Illinois River to about Utica and northward up the Wabash River to Portland Arch, Fountain County, Indiana. Ordinarily it occurs in the leaf mold of forests or in *Andropogon* clumps at the edges of forests.



Fig. 211. — *Amphibolothrips (Trachythrips) watsoni*, dorsal aspect.

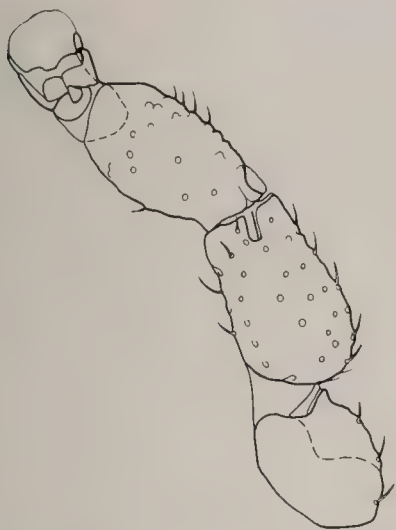


Fig. 212.—*Amphibolothrips (Trachythrips) watsoni*, fore leg.

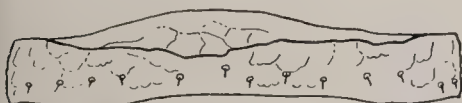


Fig. 213.—*Amphibolothrips (Trachythrips) watsoni*, pelta.

Illinois records (Fig. 20).—Taken every month of the year, from one or several localities in the following counties: ALEXANDER, CALHOUN, CLARK, CLAY, COLES, CRAWFORD, EFFINGHAM, FAYETTE, HARDIN, HENRY, JACKSON, JEFFERSON, JERSEY, JOHNSON, LA SALLE, LAWRENCE, MARION, MASON, PERRY, POPE, PULASKI, RANDOLPH, SHELBY, ST. CLAIR, VERMILION, WASHINGTON, and WAYNE.

Bagnalliella Karny

Bagnalliella Karny (1920:41). Type-species by original designation.—*Cephalothrips yuccae* Hinds.

Head moderate in size and somewhat broadened anteriorly, often with depressed lines or wrinkles behind eyes especially in brachypterous forms. Eyes normal. Ocelli present in

all forms. Postocular setae usually pointed. Antennae eight segmented, each segment fairly small, none enlarged. Maxillary stylets retracted far into the head, placed fairly close together. Maxillary bridge present, short. Mouth cone broadly rounded.

Prothorax with only anterolateral, epimeral, and lateral posterior marginal setae well developed, these setae usually blunt at their tips. Praepectus present. Epimeral sutures complete. Macropterous or brachypterous. Macropterous forms with fore wing slightly narrowed at the middle or entire apical half narrowed, accessory fringe cilia present. Fore tarsi armed in both sexes.

Pelta triangular (Fig. 214). Wing-holding setae slightly curved or slightly sigmoidal. Tube moderate-sized. Accessory setae on abdominal sternites minute. Males apparently without sternal glandular areas, and with lateral posterior setae on abdominal tergite IX reduced.

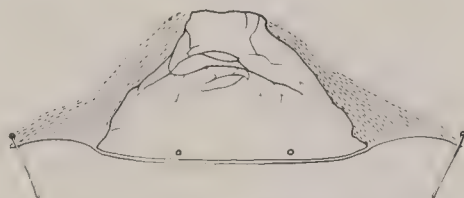


Fig. 214.—*Bagnalliella yuccae*, pelta.

This genus is similar to *Haplothrips*. From *Haplothrips*, *Bagnalliella* may be distinguished by the combination of the characteristics a) wrinkles behind eyes in the brachypterous form, b) reduction of both the anteromarginal and lateral prothoracic setae, and c) the appearance of the head outline which is slightly broadened anteriorly. In addition species of *Bagnalliella* are seemingly confined to *Yucca* plants and are rarely found on other vegetation.

Bagnalliella is represented in Illinois by the introduced species, *Bagnalliella yuccae*.

Bagnalliella yuccae (Hinds)

Cephalothrips yuccae Hinds (1902: 194). ♀, ♂. Type-locality.—Not given, but either Amherst, Massachusetts or Washington, D.C. Transferred to *Bagnalliella* by Karny (1920).

Haplothrips yuccae Savenko (1944: 1008). ♀, ♂. Type-locality.—Buknari, Kobuletsk, district of Adzharsk (Caucasus), U.S.S.R. New synonymy.

FEMALE (macropterous).—Length distended about 2.5 mm. General color light brown; sides and anterior of head, sides of thorax, and tube dark brown; abdomen sometimes yellowish brown mesally. Antennal segment I and most of II brown as in head, rest of antennae yellow except segments VII and VIII which are infused with brown. Legs predominantly brown except tarsi which are yellow. Wings colorless except extreme base light brown. Ocellar and subintegumental pigments red.

Head without strong wrinkles behind eyes. Antennal segment IV with two outer and two inner sense cones.

Major prothoracic setae moderately long. Fore tarsi each with a small tooth.

Tube moderate in size.

FEMALE (brachypterous).—Length distended over 2 mm. Color and structure almost identical to color and structure of macropterous form (color slightly darker). Evidence of some wrinkles or impressed lines behind eyes. Wings reduced to small pads.

MALE (brachypterous).—Length distended about 1.8 mm. Generally similar to brachypterous female. Abdominal sternite VIII without a glandular area.

This species is host specific to *Yucca filamentosa*, a commonly cultivated plant that originally was native to the eastern coastal plain from southern New Jersey to Georgia (Fernald 1950). *Yucca filamentosa* and its thrips *Bagnalliella yuccae* have been introduced into Illinois and many other states as well as Europe.

Savenko's species, *Haplothrips yuc-*

cae, described from the Caucasus and redescribed by Derbeneva (1959) from the Crimea, is undoubtedly the same as *Bagnalliella yuccae* Hinds. The provenience of the plant genus *Yucca* is the New World and the species most able to tolerate low winter temperatures under out-of-door cultivation in Europe are from the southeastern United States where *B. yuccae* is the sole associate. Although these Russian authors made no reference to the literature on *Bagnalliella*, their descriptions and illustrations are of a typical *Bagnalliella*.

Adults and larvae of *yuccae* may be found in the lower appressed parts of the sheaths of their host. According to my observations, winged females can fly at least one-half mile to start new colonies. Two years after I started a yucca plant from a root cutting in my garden, a colony of thrips became established on it. The nearest yucca was fully one-half mile distant from my plant.

Illinois records (Fig. 19).—State-wide, collected from April through October, from one or several localities in every county in the state.

Cephalothrips Uzel

Cephalothrips Uzel (1895:244). Type-species by monotypy.—*Phloeothrips monilicornis* Reuter.

Head decidedly longer than broad, hardly at all prolonged in front of eyes. Dorsal surface of head smooth to faintly transversely striate along the lateral margins and base, ventral surface smooth, cheeks barely serrate. Eyes moderately large, prolonged more posteriad ventrally than dorsally. Ocelli present in macropterous form, absent in apterous form. Postocular setae moderate in size. Antennae eight segmented, segment III not elongate, segments VII and VIII each with a broad pedicel. Mouth cone broadly rounded. Maxillary stylets, when at rest, extending far into the head and placed fairly close together but not touching within the center of the head.

Prothorax with only the epimeral setae well developed, these setae di-

lated at tip. Praepectus absent. Mesopraesternum degenerate, reduced to two lateral, triangular plates. Metanotum smooth medially, weakly longitudinally striate along sides of the median scutum. Macropterous or apterous. Fore wings in macropterous form without accessory setae. Fore legs each armed with a small tooth.

Pelta triangular, faintly reticulate. Wing-holding setae well formed or not differentiated. Tube moderate in size, terminal setae shorter than tube. Males unknown to me.

This genus resembles *Hoplandrothrips* and *Adraneothrips*; some students have even allied it to *Karnyothrips*, directly or indirectly. From *Karnyothrips*, *Cephalothrips* differs by lacking praepectal plates. From *Hoplandrothrips*, *Cephalothrips* differs by having the eyes prolonged posteriad more on the venter than on the dorsum. And from *Adraneothrips*, *Cephalothrips* differs by having antennal segment VII with a broad pedicel.

Cephalothrips is represented in northeastern North America by the holarctic species, *monilicornis*. As yet it has not been found in Illinois.

***Cephalothrips monilicornis* (Reuter)**

Phloeothrips monilicornis Reuter (1885: 21). ♀. Type-locality.—Finland. Transferred to *Cephalothrips* by Uzel (1895).

FEMALE (apterous).—Length distended about 2 mm. General color dark brown. Apexes of tibiae, all tarsi, and bases of antennal segments III–VI bright yellow. Body with red sub-integumental pigment.

Head elongate, smooth. Cheeks moderately serrate with several short, nearly colorless spines. Eyes moderate in size, prolonged ventrally toward the posterior into a point. Ocelli absent. Antennal segment III with one outer sense cone, antennal segment IV with one outer and one inner sense cone. Maxillary stylets, when at rest, extending far into the head and placed fairly close together but not touching within the center of the head. Mouth cone short, broadly rounded.

Prothorax with only the epimeral

setae well developed, these setae dilated at tips. Epimeral sutures complete. Pterothorax degenerate, typical of the apical condition. Fore tarsi each armed with a small tooth. Wings entirely lacking.

Pelta broadly triangular. Wing-holding setae not differentiated. Abdominal tergite IX with major posterior setae less than half as long as tube, slightly dilated at tips.

FEMALE (macropterous).—Similar in most respects to apterous female with the following exceptions. Ocelli present. Pterothorax not degenerate. Wings present. Fore wings without accessory fringe cilia. Abdomen with wing-holding setae well developed, sigmoidal.

MALE.—Known in Europe, unknown in North America.

This species can be distinguished from other long-headed, dark, slender species of the subfamily Phlaeothripinae in North America by the combination of the ventrally-produced eyes and the yellow coloring on the apexes of the fore tibiae, all of the tarsi, and the bases of antennal segments III–VI.

In North America, as in Europe, *Cephalothrips monilicornis* is confined to northern regions. It is distributed from British Columbia to New York. It is now a holarctic species, which, although not yet taken in Illinois, may be found in the future in our northern counties. I have collected this species as far south as Portage, Wisconsin. The absence of males in North America may indicate that a facultative parthenogenetic form of *monilicornis* was introduced to our continent by European man.

***Diphyothrips* Stannard**

Diphyothrips Stannard (1963b:134).

Type-species by original designation.—*Diphyothrips morainensis* Stannard.

Head slightly longer than broad, with weak, transverse striae. Eyes moderately small, shorter than combined length of antennal segments I and II, not ventrally prolonged. Ocelli present, moderately far apart, fore

ocellus overhanging insertion of antennae. Antennae eight segmented; segment III with basal half abruptly narrowed; segment VIII only slightly narrowed basally, broadly attached to segment VII. Postocular setae long. Maxillary stylets, when fully at rest, extended far into the head, placed fairly close together within the center of the head. Mouth cone moderately long, broadly rounded.

Prothorax shorter than head, nearly smooth. All major setae well developed, midlateral setae closer to epimeral suture than to anterolateral setae. Epimeral suture complete. Each epimeron divided into three parts; with two well-developed setae. Praepectus apparently absent. Metascutum nearly smooth medially with weak, elongated reticulations that tend to become longitudinal striae laterally; without long setae. Mesopraesternum bandlike, completely separated by a suture from the mesosternum. Fore femora not particularly enlarged. Fore wings of even width throughout, with accessory fringe cilia.

Pelta small, triangular to bell shaped. Wing-holding setae relatively slender, curved to nearly sigmoidal. Abdominal tergite II at sides not especially fractured into small stipple-like platelets. Abdominal tergite IX with major posterior setae much longer than tube, in female at least. Tube slightly shorter than head, terminal setae shorter than tube.

MALE.—Unknown.

This monobasic genus may be immediately recognized by the thrice divided epimeral plate. As is the case of *Illinothrips*, the genus has not yet been found outside of Illinois.

***Diphyothrips morainensis* Stannard**

Diphyothrips morainensis Stannard (1963b:136). ♀. Type-locality.—Shoefactory Road hill prairie, Cook County, near Elgin, Illinois.

FEMALE (macropterous).—Length nearly 2 mm. Color dark brown. Antennal segment III, fore tibiae, and all tarsi yellowish brown. Subintegumental pigment red. All body setae pale yellow. Wings colorless except

light brown at base including scale of fore wing.

Head (Fig. 215). Postocular setae pointed. Ocellar setae minute. Antennal segment III with one outer sense cone and no inner sense cone, segment IV with one outer and one inner sense cone.

Prothorax with all major setae long and blunt at tips. Anteromarginal setae longer than anterolateral setae. Posteromarginal setae longest, longer than length of prothorax. Pterothorax with all ventrolateral setae pointed. Fore tarsi unarmed. Fore wings with 11–13 accessory fringe cilia.

Abdomen with pelta triangular to slightly bell shaped, not abruptly expanded near posterior margin. Lateral abdominal setae becoming progressively longer on segments II–IX, only lateral setae on segment IX longer than tube. Abdominal tergite IX with all long major setae pointed at tips.

MALE.—Unknown.

In many respects this species resembles certain species in *Liothrips*. The tripartite epimeral plates of *Diphyothrips morainensis* distinguish it from all other species in Illinois.

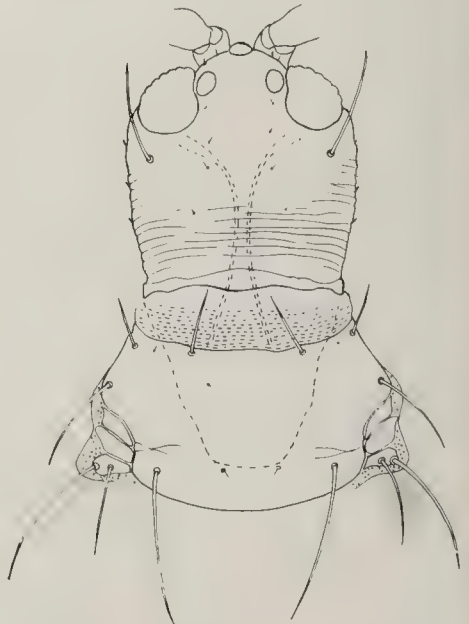


Fig. 215.—*Diphyothrips morainensis*, head and prothorax.

So far it is known only from two localities in our state.

Illinois records.—COOK COUNTY: near Elgin (Shoefactory Road hill prairie), July 28, 1953, September 21, 1961, Stannard, swept from grass, 2 ♀. LEE COUNTY: Amboy, September 13, 1951, Richards, Stannard, swept from grass, 1 ♀.

Erkosothrips Stannard

Erkosothrips Stannard (1955b:81).

Type-species by original designation.—*Erkosothrips interior* Stannard.

Head longer than wide, prolonged in front of eyes, completely hexagonally reticulate on the dorsum, cheeks slightly to considerably swollen and incised just behind eyes. Eyes moderately small, bulged. Ocelli present, somewhat reduced in brachypterous forms. Postocular setae short to very short, never longer than length of eye, always dilated. Antennae eight segmented (Fig. 199), antennal segments III and IV with several setae dilated and with slender sense cones, segment VIII pedicellate. Mouth cone short, broadly rounded. Maxillary stylets placed far apart in the form of a V within the head.

Prothorax with anteromarginal setae minute, remainder of major setae well developed but moderately short, dilated. Epimeral sutures complete or incomplete. Praepectus present. Metanotum with weak or strong hexagonal reticulations on the anterior part at least. Macropterous, brachypterous, or apterous. Fore wings when present not indented in the middle, without accessory fringe cilia. Fore tarsi each armed with a small tooth. Femora each with a differentiated outer seta which is dilated.

Abdomen hexagonally reticulate. Pelta elongate oval, rectangular, or in the form of an isosceles trapezoid. Wing-holding setae developed or not differentiated. Males with a glandular area on abdominal sternite VIII, either in the form of a narrow subbasal band or as a broad band occupying most of the segment. Abdominal tergite IX with major posterior setae shorter

than the tube, usually all dilated; in the male, the lateral setae reduced in size, pointed, blunt, or dilated. Tube shorter than head, not hexagonally reticulate, with terminal setae shorter than tube.

Members of this genus, which I have treated elsewhere (Stannard 1955b), can be characterized by the reticulate head, eight-segmented antennae in which segment VIII is pedicellate, minute anteromarginal setae, the presence of praepectal plates, and the nonhexagonally reticulate tube which is shorter than the head. The included species resemble those in *Eurythrips*, a genus characterized by not having the head entirely reticulate, as well as those in *Glyptothrips*, a genus defined as having morphological antennal segments VII and VIII fused or so closely adjoined that segment VIII is entirely without a pedicel.

Three species occur in Illinois. They may be found in grass clumps or in forest debris.

KEY TO SPECIES

1. Pterothorax with ventrolateral setae pointed.....*sculpturus*
Pterothorax with ventrolateral setae dilated.....2
2. Abdomen largely deep yellow; abdominal sternite VIII of male with narrow, bandlike, subbasal glandular area.....*interior*
Abdomen largely brown; abdominal sternite VIII of male with a broad, transverse glandular area.....*claviger*

***Erkosothrips claviger* (Hood)**

Eurythrips claviger Hood (1941:166). ♀, ♂. Type-locality.—Oswegatchie, New York. Transferred to *Erkosothrips* by Stannard (1955b).

FEMALE (brachypterous).—Length distended about 1.9 mm. General color brown and yellow. Most of head, legs, antennal segment I and sometimes pedicels of antennal segments III–V yellow to yellowish brown. Head at sides, thorax, and abdominal segment I darker yellowish brown to brown. Remainder of antennae and abdomen brown to dark brown. Body with red subintegumental pigment.

Head relatively long, cheeks de-

cidedly bulged, incised behind eyes. Eyes moderately small, bulged. Ocelli present. Postocular setae shorter than eye length, dilated. Antennal segment III with one inner and two outer slender sense cones; segment IV with two inner and two outer slender sense cones; segment VIII relatively long and slender, pedicellate. Mouth cone short, broadly rounded.

Prothorax very faintly reticulate anteriorly; with most of the major setae well developed and dilated, anteromarginal setae minute. Epimeral sutures incomplete. Pterothorax with ventrolateral setae dilated. Metanotum with reticulations grading into wartlike markings posteriorly. Wings reduced to small pads. Fore tarsi each armed with a small tooth. Femora each with an outer, differentiated, dilated seta.

Pelta roughly in the shape of an isosceles trapezoid (Fig. 216), with lateral setae placed outside of pelta. Wing-holding setae developed. Abdominal tergite IX with major posterior setae shorter than tube, dilated. Tube less than three-fourths as long as head.

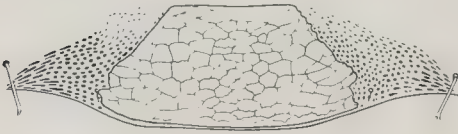


Fig. 216.—*Erkosothrips claviger*, pelta.

FEMALE (macropterous).—Unknown.

MALE (brachypterous).—Length distended about 1.4 mm. Similar to brachypterous female in color and structure except fore tarsal tooth sometimes slightly stouter. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with major lateral posterior setae shortened, pointed to blunt.

This fairly dark colored species is the only member of the genus in the Midwest whose male has the glandular area of abdominal sternite VIII in the form of a broad band that occupies most of the segment.

So far only one specimen of this species has been collected in Illinois. It was taken at Palisades State Park, Carroll County, in 1944 by Drs. M. W. Sanderson and R. Leighton, from forest debris. Most likely the range of *claviger* is continuous from Missouri to New York, across northern Illinois.

Erkosothrips interior Stannard

Erkosothrips interior Stannard (1955b: 84). ♀, ♂. Type-locality.—Monticello, Illinois.

FEMALE (brachypterous).—Length distended about 2 mm. General color deep yellow. Terminal segments of antennae shading into yellowish brown. Sides of mesothorax, abdominal tergites III–VIII, and most of tube brown to dark brown.

Head longer than broad, cheeks not especially swollen, cheeks incised behind eyes. Eyes relatively small, bulged. Ocelli present. Postocular setae about as long as dorsal eye length, dilated. Antennal segments III and IV strongly sculptured, each with one inner and one outer slender sense cone; segment VIII fairly slender, pedicellate. Mouth cone short, broadly rounded.

Prothorax so faintly marked as to appear nearly smooth, with most of the major setae well developed and dilated. Anteromarginal setae minute. Epimeral sutures incomplete. Metanotum faintly reticulate in anterior half. Pterothorax with ventrolateral setae dilated. Wings reduced to pads. Fore tarsi each armed with a small tooth. Femora each with an outer, differentiated, dilated seta.

Pelta elongate oval, with lateral setae placed outside (Fig. 217). Wing-holding setae not developed. Abdominal tergite IX with major posterior setae shorter than tube, dilated. Tube about three-fourths as long as head.

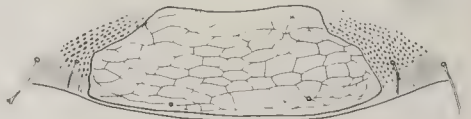


Fig. 217.—*Erkosothrips interior*, pelta.

FEMALE (macropterous).—Unknown.

MALE (brachypterous).—Length distended nearly 1.5 mm. Similar in color and structure to brachypterous female. Abdominal sternite VIII with a narrow subbasal glandular area (Fig. 57). Abdominal tergite IX with major lateral posterior setae reduced in size, dilated.

From its midwestern congeners, this species may be easily distinguished by its yellow color in combination with the presence of dilated ventrolateral pterothorax setae.

Most of the collections of *interior* have been from Illinois; elsewhere it has been found in southern Michigan and Missouri. All specimens have been taken from forest debris.

Illinois records.—CLARK COUNTY: Clarksville, May 13, 1949, Ross, Gloyd, Stannard, forest debris, 1 ♀. COOK COUNTY: Woodlawn, May 16, 1948, Stannard, forest debris, 1 ♀. DOUGLAS COUNTY: Arcola, October 12, 1949, Stannard, forest debris, 1 ♀. LA SALLE COUNTY: Serena, October 20, 1960, Evers, Stannard, forest debris, 1 ♀. LAWRENCE COUNTY: West Point, September 15, 1949, Ross, Stannard, 1 ♂. MARION COUNTY: Fairman, April 10, 1956, Stannard, forest debris, 1 ♀. MENARD COUNTY: New Salem State Park, April 3, 1956, Stannard, forest debris, 1 ♀, 2 ♂. PIATT COUNTY: Monticello, November 16, 1937, September 25, 28, 1938, April 14, 1942, Farrar, forest debris, 3 ♀, 7 ♂; Monticello, April 12, 1961, Moll, Stannard, forest debris, 1 ♀.

***Erkosothrips sculpturus* (Hood)**

Eurythrips sculpturus Hood (1936a:5). ♀, ♂. Type-locality.—Tallulah, Louisiana. Transferred to *Erkosothrips* by Stannard (1955b).

FEMALE (brachypterous).—Length distended about 1.7 mm. General color brown and yellow. Head and legs bright yellow. Basal antennal segments, thorax, abdominal tergite I, and sometimes abdominal tergite IX predominantly yellowish brown. Apical antennal segments and remainder of abdomen brown. Abdominal ter-

gites III–VIII with median interior blotch and tube often dark brown. Body with red subintegumental pigment.

Head about $1\frac{1}{3}$ times as long as wide, cheeks slightly swollen, incised sharply behind eyes (Fig. 218). Eyes relatively small, bulged. Small ocelli present. Postocular setae short, usually placed well inside a line tangent to the lateral eye margin, dilated. Antennal segments III and IV each with one inner and one outer slender sense cone, segment VIII with a moderately broad pedicel. Mouth cone short, broadly rounded.

Prothorax with faint hexagonal reticulations anteriorly, with most of the major setae well developed and dilated, anteromarginal setae minute. Epimeral sutures complete or nearly complete. Pterothorax with ventrolateral setae pointed. Wings reduced to tiny pads. Fore tarsi each armed with a small tooth. Femora each with an outer, differentiated, dilated seta.

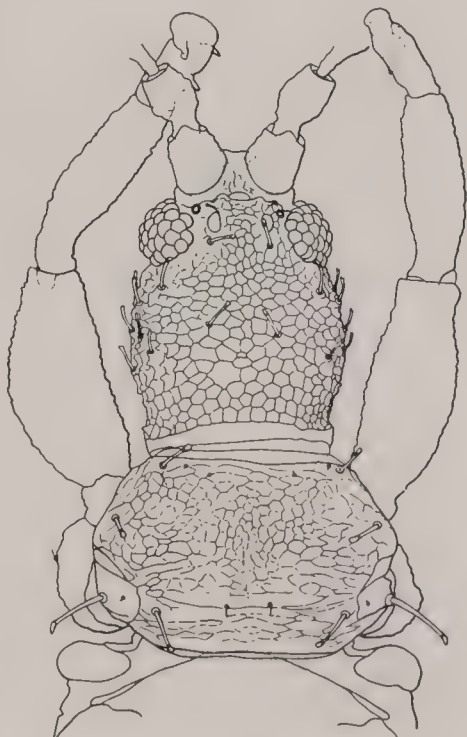


Fig. 218.—*Erkosothrips sculpturus*, head and prothorax. From Hood (1936a).

Pelta elongate oval, with lateral setae usually placed on pelta (Fig. 219). Wing-holding setae not developed. Abdominal tergite IX with major posterior setae shorter than tube, dilated. Tube slightly more than three-fourths as long as head.

FEMALE (macropterous) (specimen from North Carolina).—Length not distended about 1.3 mm. Similar to brachypterous female. Wings fully developed, fore wing uniformly light brown, without accessory fringe cilia. Wing-holding setae well developed.

MALE (brachypterous).—Length distended about 1.3 mm. Color and structure similar to brachypterous female. Abdominal sternite VIII with a narrow, subbasal, bandlike glandular area. Abdominal tergite IX with major lateral posterior setae reduced in size, pointed to dilated.

In the Illinois fauna, *sculpturus* is the only species in the genus with pointed ventrolateral pterothoracic setae.

The status of this species is still uncertain. In 1955 I supported the view that *sculpturus* and *silvarum* were distinct. Now, with more material at hand, it appears that there is little if any distinction between them. Two characteristics, the extent of the swollen cheeks and the placement of the postocular setae, have proved to be so variable that they can no longer be used as criteria for the separation of these forms. It may be that *silvarum* is but the apterous form of *sculpturus*. For the present, I prefer to use the name *sculpturus* for specimens in Illinois. No decision on *silvarum* is necessary in considering our fauna because no specimens assignable to *silvarum* have yet been found in our state.

The very similar-appearing type-specimen of *Erkosothrips reticulatus* (Watson) from Florida has a yellow (rather than brown) tube and the posterior setae of abdominal tergite IX are blunt to pointed, not dilated. Apparently, *reticulatus* may be distinguished from *sculpturus* by these two characteristics. The lectotype of *reticulatus*, described by Watson under *Glyptothrips* in 1934, is herein design-



Fig. 219.—*Erkosothrips sculpturus*, pelta.

nated to be the single female specimen, probably brachypterous, mounted ventral side up on the slide deposited in the Watson collection, Florida Agricultural Experiment Station, Gainesville, marked "TYPE ♀" and labeled "damp leaves along stream in Catocala Glen, Gainesville, Florida, separated in Berlese funnel, 1.12.26, D. M. Bates coll."

Erkosothrips sculpturus has been collected from the central and southern parts of Illinois in grass clumps and forest debris.

Illinois records.—**BOND COUNTY:** Smithboro, October 28, 1956, Ross, Smith, Stannard, forest debris, 2 ♀, 1 ♂. **DOUGLAS COUNTY:** Arcola, October 12, 1949, Stannard, sod of *Andropogon*, 3 ♀, 3 ♂. **JACKSON COUNTY:** Murphysboro, September 20, 1949, Smith, Stannard, ground cover, 2 ♀, 1 ♂. **JOHNSON COUNTY:** Grantsburg, August 31, 1951, Ross, Richards, from grass and leaves, 5 ♀, 8 ♂; Sanburn, September 20, 1949, Smith, Stannard, forest debris, 2 ♀, 1 ♂. **MARION COUNTY:** Fairman, April 10, 1956, Stannard, forest debris, 1 ♂. **PIATT COUNTY:** Monticello, October 17, 1938, December 11, 1939, April 5, 1940, Farrar, sod of *Andropogon* and woodland debris, 5 ♀, 1 ♂. **POPE COUNTY:** Herod, May 5, 1950, Sanderson, Stannard, forest and grass debris, 4 ♀, 2 ♂. **RANDOLPH COUNTY:** Prairie du Rocher, July 18, 1948, Smith, Stannard, forest and grass debris, 1 ♀.

Eschatothrips Stannard

Eschatothrips Stannard (1955b:88).

Type-species by original designation.—*Eurythrips reticulotubus* Stannard.

Head longer than wide, slightly prolonged anterior of eyes, dorsum entirely sculptured by hexagonal reticu-

lations, cheeks decidedly incised just behind eyes. Eyes bulged, keglike. Ocelli present in all forms known. Postocellar setae minute. Postocular setae small. Antennae eight segmented; segments III and IV each with two dorsal setae that are knobbed or blunt, sense cones long and slender; segment VIII with narrow pedicel. Mouth cone short, broadly rounded. Maxillary stylets placed far apart within head, extending anteriorly to region of postocular setae.

Prothorax short, faintly reticulate. Anteromarginal setae minute; anterolateral, midlateral, and posterior marginal setae moderate in size, pointed to blunt; epimeral pair of setae largest, thickened and expanded at tips. Epimeral sutures complete. Praepectal plates extremely large. Mesopraesternum well developed. Macropterous or micropterous; fore wings, when fully developed, without accessory fringe cilia.

Abdominal tergites hexagonally reticulate except for medioanterior region where they are transversely striate. Pelta rectangular. Tergites III–VI each with two pairs of sigmoidal wing-holding setae, even in micropterous form. Lateral posterior setae thickened, blunt at tips. Abdominal sternite VIII in male with glandular area. Abdominal tergite IX of female with midposterior setae blunt, lateral setae long and pointed; in male, lateral setae greatly reduced, spinelike. Tube moderate in size, hexagonally reticulate except at tip (Fig. 188); anal setae shorter than tube.

In the eastern United States, other similar-appearing genera in the Phlaeothripinae differ from *Eschatothrips* by several characteristics among which are the following: in *Eurythrips* the head is never completely reticulate, in *Glyptothrips* the antennae are either each seven segmented or segment VIII is nonpedicellate, and in *Erkosothrips* the tube is not reticulate.

Although the genus has not yet been found in Illinois, specimens of *Eschatothrips barythripoides* have been taken in the Cumberland Mountains of Kentucky. Therefore, as is the case with some other insects of possible similar

distribution, it is likely that populations also exist nearer to or actually in our state.

***Eschatothrips barythripoides* Watson**

Glyptothrips barythripoides Watson (1935:55). ♀, ♂. Type-locality.—Petersburg, Virginia; see remarks concerning lectotype below. Transferred to *Eschatothrips* by Stannard (1955b).

FEMALE (micropterous).—Length distended about 1.8 mm. Color predominantly yellow. Antennal segments IV–VI, except for pedicels, and all of segments VII and VIII brown. Abdominal tergites II–VII each with a median anterior brown spot, tube orange yellow except grayish brown at apex. Setae yellow. Body with some red subintegumental pigment.

Head completely reticulate dorsally. Eyes small, bulged. Antennal segment III with one ventral sense cone, segment IV with one inner and one outer sense cone. Mouth cone proportionately small.

Prothorax with sculpture faint. Praepectus present. Pterothorax without well-developed ventrolateral setae. Metascutum strongly hexagonally reticulate. Wings short, extending only to abdominal segment I or II, nearly brachypterous. Fore tarsi unarmed.

Pelta hexagonally reticulate. Abdominal tergite IX with major posterior lateral setae more than half as long as tube. Tube slightly longer than head.

FEMALE (macropterous).—Similar in size, color, and structure to micropterous female. Fore wings lacking accessory fringe cilia.

MALE (micropterous).—Length distended about 1.6 mm. Similar to micropterous female in color and structure. Abdominal sternite VIII with a bandlike glandular area in the antero-median portion. Abdominal tergite IX with major lateral posterior setae (II) small and spinelike. Tube decidedly shorter than head.

This is the only species of the genus in the temperate eastern United States, occurring from Florida to New

Jersey and Mississippi to Kentucky. It has not yet been discovered in Illinois.

The lectotype of *barythripoides*, described by Watson under *Glyptothrips* in 1935, is here designated to be the male specimen encircled with black ink on the slide marked "type ♂" in which the designation "para" preceded "type" but was subsequently marked out by Professor Watson or another person and further labeled "Petersburg, Virginia, IX.3.33, J. W. Kea, dead oak leaves." This male is mounted ventral side up and is micropterous with the wing pads reaching to abdominal segment II. None of those in the type series in the Watson collection, Florida Agricultural Experiment Station, Gainesville, is "apartous," *lapsus calami* by Watson for "apterous," as far as can be determined. Also on the lectotype slide is a specimen of *Hoplothrips pergandei*.

Although Watson indicated in the original description that the type was a female, only slides which are or once were labeled "paratypes" remain in the Watson collection. It seems reasonable to presume that Watson crossed out the phrase "para" and deliberately selected the male as type but failed to change the designation in his manuscript. At any rate the lectotype selected here is clearly a representative of the species Watson had in mind when he wrote his description.

Eurythrips Hinds

Eurythrips Hinds (1902:202). Type-species by original designation.—*Eurythrips ampliventralis* Hinds.

Zuluella Jacot-Guillarmod (1939:37). Type-species by original designation.—*Zuluella distincta* Jacot-Guillarmod. New synonymy.

Head moderate in size to elongated, sometimes considerably prolonged forward of eyes; surface of head never completely reticulate, usually smooth on the median of the dorsum or with faint warts, smooth on venter or with transverse striae; usually incised behind eyes. Eyes often bulged, kegelike. Ocelli present in macropterous and

some brachypterous forms, reduced or absent in some brachypterous and apterous forms. Postocellar setae usually small (long in *tarsalis*). Postocular setae well developed, dilated or pointed. Antennae eight segmented, segment III with one inner and one or two outer sense cones, segments VII and VIII with narrow or broad pedicels, usually setae on all segments pointed (except in *virginianus*). Mouth cone generally broadly rounded. Maxillary stylets placed far apart within head.

Prothorax with most major setae well developed, dilated or pointed; anteromarginal setae small. Epimeral sutures often incomplete. Praepectal plates always present. Fore wings brown when fully developed, without accessory fringe cilia in the North American species. Ventrolateral metathoracic setae usually small and pointed (except in *setiger*). Fore legs each usually with a tarsal tooth, mid and hind legs usually without any large, differentiated setae (except in *setiger*).

Pelta moderate in size. Wing-holding setae often present even in brachypterous forms. Males with glandular area on abdominal sternite VIII either in the form of a broad or narrow band or, as in *batesi*, divided into two parts (Fig. 56), and with posterior lateral setae on abdominal tergite IX shorter than in female.

In Illinois this genus resembles *Erksothrips* and *Glyptothrips*. The latter two genera have the head completely covered by hexagonal reticulations, whereas in *Eurythrips* the dorsal median part of the head is either smooth or with only faint warts. Also *Eurythrips* resembles *Haplothrips* in many features. However, in *Eurythrips* the maxillary stylets are always placed far apart within the head, almost next to the sides of the head, and usually the eyes are more bulged than in *Haplothrips*.

At least 12 species of *Eurythrips* occur in Illinois. Many are found in grass clumps, particularly *Andropogon*, and a few are found in forest litter. They are not known to be of economic importance.

KEY TO SPECIES

(ILLINOIS, EXCEPT WHERE NOTED)

- 1. Postocellar setae long.....**tarsalis**
Postocellar setae short (Fig. 220 and 221).....2
- 2. Mid and hind femora each with a large dorsal seta which is dilated; ventrolateral metathoracic setae prominent and dilated.....**setiger**
Mid and hind femora without any differentiated setae; ventrolateral metathoracic setae small and pointed.....3
- 3. Abdominal segments I, II, and sides of III abruptly yellow in contrast to remainder of abdomen which is brown; head faintly warty on dorsum; pelta as in Fig. 222.....**pettiti**
Abdomen variously colored but not abruptly yellow in two or more basal segments in contrast to remainder of abdomen; head usually smooth on median part of dorsum; peltae variously formed.....4
- 4. Epimeral sutures complete.....5
Epimeral sutures incomplete.....6
- 5. Tube dark brown.....**dissimilis**
Tube light yellow; from Alabama and Virginia (USNM), not yet found in Illinois.....**forticornis**
- 6. Males.....7
Females.....14
- 7. Abdominal sternite VIII with glandular

- area divided into two parts (Fig. 56).....**batesi**
- Abdominal sternite VIII with glandular area complete, bandlike.....8
- 8. Glandular area thin.....9
Glandular area broad to moderately broad.....11
- 9. Glandular area occupying central portion of abdominal sternite VIII.....**constrictus**
Glandular area occupying anterior portion of abdominal sternite VIII.....10
- 10. Predominantly yellow; dorsal setae on antennal segment III all pointed.....**watsoni**
Abdomen with much brown, particularly tergites II and III and sides of posterior segments; two dorsal setae on antennal segments III blunt or dilated.....**virginianus**
- 11. Abdominal tergite IX with median pair of posterior setae extending beyond the tube.....12
Abdominal tergite IX with median pair of posterior setae not extending beyond the tube.....13
- 12. Antennal segments III and IV short and decidedly angular in profile; major prothoracic setae long, pointed; tube usually orange-brown at base.....**hindsii**
Antennal segments III and IV slightly longer and not as angular in profile; major prothoracic setae blunt or dilated; tube usually brown at base.....**osborni**
- 13. Antennal segment VII relatively long and pedicel relatively narrow.....

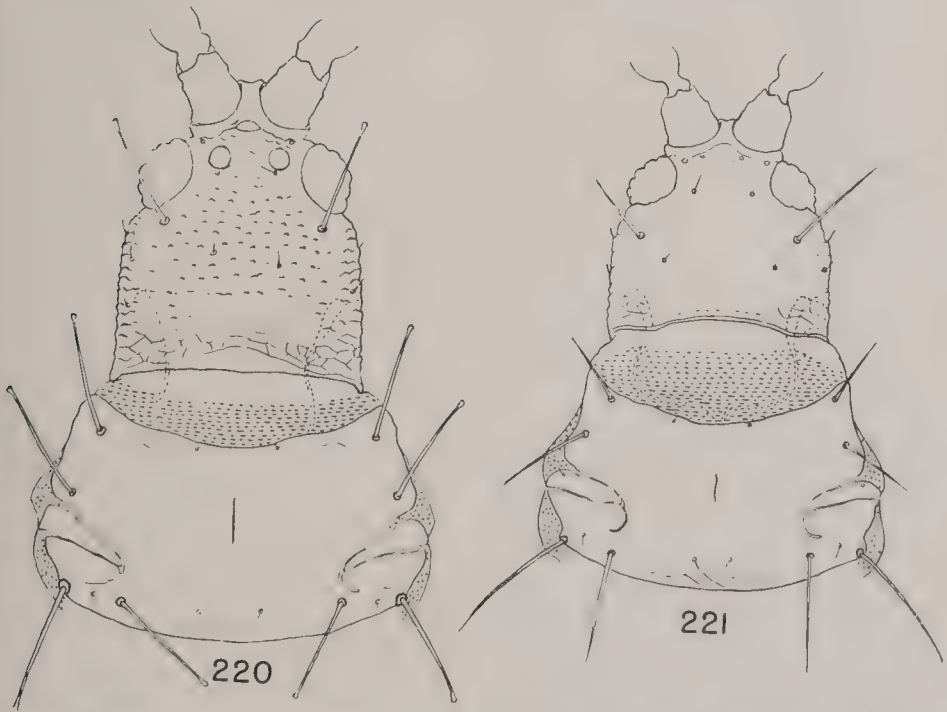


Fig. 220-221.—Head and prothorax: 220, *Eurythrips pettiti*; 221, *Eurythrips hindsii*.

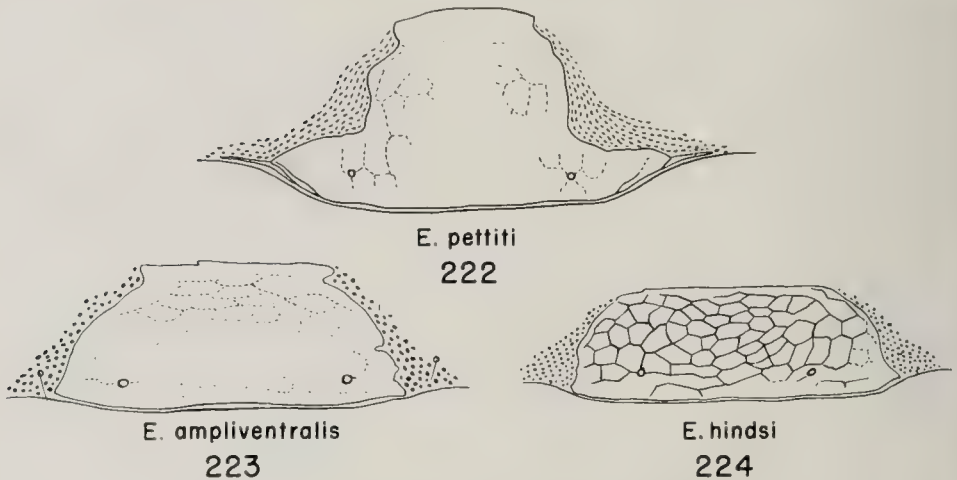


Fig. 222-224.—Peltas of indicated species of *Eurythrips*.

- ampliventralis**
- Antennal segment VII shorter and pedicel broad. **connatus**
14. Abdominal tergite IX with major posterior setae dilated. 15
- Abdominal tergite IX with major posterior setae pointed. 17
15. Head with most of ventral surface covered with transverse striations. **batesi**
- Head with ventral surface transversely striated only on anterior portion. 16
16. Abdomen predominantly yellow; antennal segment III with all dorsal setae pointed. **watsoni**
- Abdomen with much brown particularly at sides; antennal segment III with two dorsal setae dilated or blunt. **virginianus**
17. Abdominal tergite IX with median pair of posterior setae extending beyond the tube. 18
- Abdominal tergite IX with median pair of posterior setae not extending beyond the tube. 19
18. Antennal segments III and IV short and decidedly angular in profile; major prothoracic setae long and pointed, rarely blunt; tube usually orange-brown at base. **hindsii**
- Antennal segments III and IV slightly longer and not as angular in profile; major prothoracic setae dilated; tube brown at base. **osborni**
19. Antennal segment III with two outer sense cones. **ampliventralis**
- Antennal segment III with one outer sense cone. 20
20. Maxillary stylets, when at rest, usually extended anteriorly to the halfway mark between the base of the eyes and the base of the head. **constrictus**
- Maxillary stylets, when at rest, basad of the halfway mark between the base of the eyes and the base of the head. **connatus**

Eurythrips ampliventralis Hinds

Eurythrips ampliventralis Hinds (1902: 202). ♀. Type-locality.—Amherst, Massachusetts.

FEMALE (brachypterous).—Length distended over 2 mm. General color brown and yellow, being predominantly yellow in the head, becoming yellowish brown to brown in the thorax, and becoming dark brown in the abdomen. Antennal segments I and II yellow to yellowish brown, segment III yellowish brown to brown, remainder of antennae brown. Legs yellow to yellowish brown. Body with red subintegumental pigment.

Head elongate, smooth dorsally and ventrally except for sides and base, constricted behind eyes, with a small toothlike projection behind eyes. Eyes bulged. Ocelli absent. Postocular setae well developed, dilated. Antennal segments III and IV each with one inner and two outer sense cones, segment VII longer than in *connatus* and with pedicel narrow to moderately broad but never as broad as in *connatus*, segment VIII with a broad pedicel. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Epimeral sutures incomplete. Major prothoracic setae well developed, dilated. Ventrolateral metathoracic setae small and pointed.

Fore tarsi each with a minute tooth. Mid and hind femora without any unusual, differentiated setae. Wings reduced to pads which usually bear three dilated setae.

Pelta broad (Fig. 223). Wing-holding setae reduced. Major posterior setae on abdominal tergite IX not exceeding the tube, pointed.

FEMALE (macropterous) (Fig. 51).—Length distended over 2 mm. Similar to brachypterous female except for the following differences. Color darker, generally brown, including the head; legs and antennal segments I and II yellowish brown to brown. Eyes more bulged from head. Ocelli present. Wings fully developed. Wing-holding setae sigmoidal, one major and one minor pair on abdominal tergites III–VII.

MALE (brachypterous).—Length distended about 1.6 mm. Similar to brachypterous female except for the following. Abdominal sternite VIII with a broad, wide, bandlike glandular area (Fig. 54). Abdominal tergite IX with lateral setae reduced in size.

This, the type of the genus, exhibits considerable variation in structure and color. The pedicel of antennal segment VIII is always broad, whereas, in contrast, the pedicel of segment VII varies from narrow to moderately broad. Even so *ampliventralis*, in extreme cases, does not have as broad a pedicel on antennal segment VII as does *connatus*. The presence of two outer sense cones on antennal segment III and the more yellow color of the head help separate brachypterous forms of *ampliventralis* from *connatus*, a species having only one outer sense cone on antennal segment III and whose head is usually darker in color.

Eurythrips ampliventralis is common throughout Illinois in *Andropogon* sod.

Illinois records.—Taken every month of the year, from one or several localities in the following counties: ADAMS, ALEXANDER, CALHOUN, CASS, CHAMPAIGN, CLARK, CLAY, COLES, COOK, DE WITT, DOUGLAS, IROQUOIS, JACKSON, JERSEY, JOHNSON, KNOX, LAKE, MONTGOMERY, PIATT, PIKE, POPE, RICHLAND, SCOTT, VERMILION, and WAYNE.

Eurythrips batesi (Watson)

Glyptothrips batesi Watson (1935:56). ♀, ♂. Type-locality.—Devil's Mill Hopper, Alachua County, Florida. Transferred to *Eurythrips* by Hood (1941).

FEMALE (brachypterous).—Length distended over 1.7 mm. General color as in *ampliventralis*. Head yellow, thorax yellowish brown to light brown, abdomen brown becoming dark brown in terminal segments. Antennae yellowish brown to yellow in basal segments becoming dark brown in apical segments. Legs yellow. Body with red subintegumental pigment.

Head moderate in size, usually smooth on the median of the dorsum, strongly transversely striate on the venter, constricted behind eyes, with a small toothlike projection behind eyes. Eyes bulged. Ocelli absent or if present greatly reduced. Postocular setae well developed, dilated. Antennal segment III with one inner and one outer sense cone and with all dorsal setae pointed, segment IV with one inner and two outer sense cones, segments VII and VIII with narrow pedicels. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Major prothoracic setae well developed, dilated. Epimeral sutures incomplete. Ventrolateral meta-thoracic setae small and pointed. Fore tarsi each with a moderate-sized tooth. Mid and hind femora without any unusual, differentiated setae. Wings reduced to pads which usually bear two dilated setae.

Pelta rectangular, usually hexagonally reticulate. Wing-holding setae greatly reduced. Major posterior setae on abdominal tergite IX not extending beyond the tube, dilated.

FEMALE (macropterous).—Unknown to me.

MALE (brachypterous).—Length distended about 1.3 mm. Similar to brachypterous female except for the following. Abdominal sternite VIII with two rectangular glandular areas (Fig. 56), these areas sometimes partially connected in what appear to be abnormal conditions. Abdominal ter-

gite IX with lateral setae reduced in size and pointed. This species is unique on the basis of the form of the male glandular area, which is usually divided into two parts, and by the strong, transverse striations on the ventral surface of the head.

Eurythrips batesi is a southern species occurring in Florida, the southern half of Illinois, Kentucky, Tennessee, Maryland, Mississippi, Missouri, North Carolina, South Carolina, and Texas (INHS records). A similar species, if not a variant of the same species, occurs in New Mexico, Mexico, and Jamaica. These populations have brown coloring in part or most of the head, and the antennae are somewhat elongate. Otherwise they are like the typical form of the populations in the southern states.

Hood (1941) designated the lectotype, a female, by marking with a diamond-pointed pencil the words "HOLOTYPE (upper specimen)" on the slide containing a mixed series of thrips from Devil's Mill Hopper, Alachua County, Florida. The present location of this slide is unknown to me. In the Watson collection there is another slide marked "Wing ♀, type, north of Ormond, Florida, June 28, 1936, dead leaves of Palmetto, Oak." This specimen cannot be considered part of the type-series, as it was collected after the original description was published. According to Watson, *batesi* was named after Marston Bates who first collected the species at Gainesville, Florida. Presumably Watson was referring to a specimen labeled "Type ♂, Gainesville, Florida, damp leaves along stream in a Catocala Glen, separated in a Berlese funnel, 1-12-26, D. M. Bates coll." Unfortunately, this thrips is not a *Eurythrips* but rather an *Erkosothrips*. This appears to be an incongruous situation in which the species honoring Dr. Bates is one he did not collect.

My concept of the species *batesi* is based on a specimen in the Watson collection labeled "Type ♂, leaves under live oak 90 feet out of Sugarfoot smock, Gainesville, Florida, 1-19-1936, J.R.W." It has the glandular

area on abdominal sternite VIII divided in the middle.

Illinois records.—FAYETTE COUNTY: Ramsey, April 18, 1954, Smith, Stannard, forest litter, 1 ♀. HARDIN COUNTY: Karbers Ridge, May 4, 1950, Sanderson, Stannard, forest debris, 2 ♀. JACKSON COUNTY: Gorham (Fountain Bluff), September 6, 1956, Smith, Stannard, forest debris, 2 ♀, 1 ♂. JOHNSON COUNTY: Buncombe, "Cedar Bluff," March 15, 1961, Evers, Stannard, forest debris, 1 ♂. POPE COUNTY: Dixon Springs, August 30, 1951, Ross, Stannard, forest debris, 2 ♀, 1 ♂; Herod, May 5, 1950, Sanderson, Stannard, forest debris, 2 ♀.

Eurythrips connatus Hood

Eurythrips connatus Hood (1938c:378).
♀. Type-locality.—Clearwater, Florida.

FEMALE (brachypterous).—Length distended about 1.7 mm. Color: head and thorax yellowish brown, abdomen brown becoming dark brown in posterior segments, legs yellow to light yellowish brown, antennae yellowish brown in basal segments, brown in terminal segments. Body with much red subintegumental pigment.

Head moderate in size, slightly longer than in *hindsii* but not as long as in *ampliventralis*, smooth dorsally and ventrally except extreme sides and base, slightly constricted behind eyes, usually with a toothlike projection behind eyes. Eyes bulged. Ocelli absent. Postocular setae well developed, slightly shorter than in *ampliventralis*, blunt to dilated at tips. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones, segment VII shorter and with pedicel broader than in *ampliventralis*, segment VIII with a broad pedicel. Mouth cone longer and heavier than in *ampliventralis*. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Epimeral sutures incomplete. Major prothoracic setae well developed, dilated. Ventrolateral met-

athoracic setae small and pointed. Fore tarsi each with a minute tooth, or tooth seemingly absent. Mid and hind femora without any unusual, differentiated setae. Wings reduced to pads which bear two or sometimes three dilated setae.

Pelta broad, much as in *ampliventralis*. Wing-holding setae reduced. Major posterior setae on abdominal tergite IX not extending beyond the tube, pointed.

MALE (brachypterous).—Length distended about 1.3 mm. Color much as in female except head sometimes more yellow than yellowish brown. Abdominal sternite VIII with a wide glandular area which is slightly narrower than in *ampliventralis*. Abdominal tergite IX with lateral setae reduced in size.

This is the only species of *Eurythrips* in Illinois with antennal segment VII having exceptionally widened pedicels. In this feature, *connatus* is similar to the tropical *amplus* and *conjunctus*, but the latter two species differ in having two, instead of one, outer sense cones on antennal segment III.

At first glance *connatus* might be mistaken for *ampliventralis*. The two can be recognized by several characteristics which are best appreciated by reference to actual specimens. Besides the condition of a slightly more narrowed pedicel on antennal segment VII, *ampliventralis* differs in having a longer head which is usually predominantly yellow instead of yellowish brown in the brachypterous form and, in the males, the glandular area on abdominal sternite VIII is broader than in *connatus*. In addition, *connatus* resembles *constrictus* but the two may be easily distinguished by the form of the male glandular area and less easily by the width of the seventh antennal segment.

I have based my concept of *connatus* on specimens from two Illinois localities and from the Everglades National Park, Florida.

Illinois records.—HENDERSON COUNTY: Oquawka, May 9, 1952, Mills, Stannard, grass sod, 3 ♀, 1 ♂.

LAKE COUNTY: October 23, 1949, Decker, sod of *Andropogon*, 1 ♀.

Eurythrips constrictus Stannard

Eurythrips constrictus Stannard (1958a:272). ♀, ♂. Type-locality. —Mammoth Cave National Park, Kentucky.

FEMALE (brachypterous).—Length distended about 1.7 mm. General color brown, head and thorax lighter becoming yellowish brown especially at base and apex of head, posterior segments of abdomen becoming dark brown. Legs and antennal segments I and II yellowish brown. Body with red subintegumental pigment.

Head moderate in size, about as in *connatus*, smooth dorsally and ventrally except at extreme sides and base, constricted under the posterior facet of the eyes, and at this point usually with a toothlike projection. Eyes bulged. Ocelli absent. Postocular setae well developed, dilated. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones, segment VII intermediate in size with pedicel moderately thickened varying from the condition in *ampliventralis* to almost the broad condition in *connatus*, segment VIII with a broad pedicel. Maxillary stylets usually retracted into head well beyond the midway point between the base of the eye and the base of the head.

Prothorax with anteromarginal setae minute, remainder of major prothoracic setae well developed, dilated. Epimeral sutures incomplete. Ventrolateral metathoracic setae small and pointed. Fore tarsi each with a minute tooth. Mid and hind femora without any unusual, differentiated setae. Wings reduced to pads which bear one or two dilated setae.

Pelta broad, much as in *ampliventralis*. Wing-holding setae reduced. Major posterior setae on abdominal tergite IX not extending beyond the tube, pointed.

MALE (brachypterous).—Length distended about 1.3 mm. Color and

structure much as in brachypterous female. Abdominal sternite VIII with a narrow, median transverse glandular area. Abdominal tergite IX with lateral setae reduced in size.

The name of this species refers to the constricted, narrow, glandular band of the male which is a principal feature for its differentiation. In one characteristic, the moderately thickened pedicel of antennal segment VII, *constrictus* stands intermediate between *ampliventralis* and *connatus*. Usually females of *constrictus* can be distinguished from *ampliventralis* and *connatus* by the position of the maxillary stylets. In *constrictus* these stylets extend well beyond the half-way mark between the base of the eyes and the base of the head whereas in the other two species these stylets are placed more basally in the head.

The species *genarum* Hood (1957) is apparently very similar to *constrictus*, but *constrictus* bears only one outer sense cone on antennal segment III in contrast to *genarum* which is described as having two outer sense cones, and by these characteristics the two may be separated. Males of both these species have narrow glandular areas.

Illinois record.—LAWRENCE COUNTY: Red Hills State Park, April 30, 1950, Stannard, sod of *Andropogon*, 21 ♀, 15 ♂.

Eurythrips dissimilis Hood

Eurythrips dissimilis Hood (1938a: 365). ♀. Type-locality.—Sebring, Florida.

FEMALE (brachypterous).—Length distended about 1.9 mm. General color brown becoming blackish brown in the terminal segments of the abdomen. Anterior part of head yellowish brown to nearly yellow. Antennae yellow in segment I becoming gradually darker brown in the apical segments. Legs yellowish brown. Body with red sub-integumental pigment.

Head moderate in size, smooth dorsally and ventrally except for transverse sculpture at base and extreme sides. Eyes bulged from head. Ocelli

present but slightly reduced in size. Postocular setae relatively small, pointed to blunt, placed close to eyes. Antennal segment IV globose but not angulate, segment VIII broadly attached to segment VII. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones. Maxillary stylets placed fairly far apart within head.

Prothorax with anteromarginal setae minute. Epimeral sutures complete. Major prothoracic setae relatively short, pointed to blunt at tips. Ventrolateral metathoracic setae small, pointed. Fore tarsi each with a strong tooth. Mid and hind femora without any long, unusual, differentiated setae. Wings reduced to pads.

Pelta roughly triangular. Wing-holding setae minute. Major posterior setae on abdominal tergite IX slightly shorter than tube, pointed. Tube nearly $1\frac{3}{4}$ times the length of abdominal tergite IX.

FEMALE (macropterous).—Unknown.

MALE (brachypterous).—Length distended over 1.6 mm. Similar in general color to brachypterous female. Abdominal sternite VIII not visible in the material that I have studied. Abdominal tergite IX with lateral setae reduced in size.

This species is not typical of the genus *Eurythrips*. Because of its features of bulged eyes and lack of a maxillary bridge it is best placed in *Eurythrips* rather than in a complex or subgenus of *Haplothrips*.

Like *setiger*, *dissimilis* has the prothoracic epimeral sutures complete. From *setiger*, it can be distinguished by the short, pointed or nearly pointed postocular setae, the large fore tarsal teeth, and the lack of a long seta on each of the mid and hind femora.

Eurythrips dissimilis has been taken three times in Illinois. In the collections of the Illinois Natural History Survey there are additional specimens from Iowa and Florida.

Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 9, 1951, Richards, Stannard, grasses, 1 ♂. FAYETTE COUNTY: La Clede, July

7, 1950, Ross, Stannard, prairie, 1 ♀. HENDERSON COUNTY: Oquawka, May 9, 1952, Mills, Stannard, grass sod, 1 ♀, 2 ♂.

Eurythrips hinds Morgan

Eurythrips hinds Morgan (1913:27).

♀. Type-locality.—Clarksville, Tennessee.

FEMALE (brachypterous).—Length distended about 1.9 mm. General color brown. Fore part of head tending to become yellowish brown. Antennal segments I–V yellow to yellowish brown to almost entirely brown. Legs, except coxae, yellow to yellowish brown. Tube usually orange-brown at base. Body with red subintegumental pigment.

Head moderate in size, smooth dorsally and ventrally except at extreme sides (Fig. 221). Eyes slightly bulged from head (moruloid). Ocelli absent. Postocular setae long and pointed at tips. Antennal segments III and IV short and decidedly angular in profile, segment VIII with a short pedicel that is usually slightly more slender than in *ampliventralis*. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Epimeral sutures incomplete. Major prothoracic setae long, pointed at tips. Ventrolateral meta-thoracic setae pointed. Fore tarsi without teeth in addition to the usual pair of terminal claws. Mid and hind femora without any unusual, differentiated setae. Wings reduced to tiny pads.

Pelta (Fig. 224) smaller than in *ampliventralis*, not as expanded anteriorly as in *osborni*. Wing-holding setae reduced. Major posterior setae on abdominal tergite IX much longer than tube, pointed. Tube about twice the length of abdominal tergite IX.

FEMALE (macropterous).—Length distended about 1.5 mm. Similar to brachypterous female except for the following. Eyes more bulged from head. Ocelli present. Wings fully developed. Wing-holding setae sigmoid-

al, one pair each on abdominal tergites III–VII.

MALE (brachypterous).—Length distended about 1.7 mm. Similar to brachypterous female except for the following. Abdominal sternite VIII with a broad, bandlike glandular area. Abdominal tergite IX with lateral setae reduced in size.

This species can be distinguished, sometimes with difficulty, from *osborni* by the shape of antennal segments III and IV and by the form of the major head and prothoracic setae as mentioned in the key. Populations nearly intermediate between typical *hinds* and typical *osborni* occur in east-central Illinois.

Eurythrips hinds is common throughout Illinois. It inhabits *Andropogon* clumps.

Illinois records.—Taken almost every month of the year, from one to several localities in the following counties: ADAMS, CHAMPAIGN, CLARK, COLES, CUMBERLAND, HANCOCK, IROQUOIS, LAKE, LAWRENCE, POPE, and VERMILION.

Eurythrips osborni Hinds

Eurythrips osborni Hinds (1902:203).

♀, ♂. Type-locality.—Amherst, Massachusetts.

FEMALE (brachypterous to nearly apterous).—Length distended about 1.4 mm. General color brown. Head yellow to yellowish brown to brown. Basal antennal segments yellowish brown to brown. Legs yellow to yellowish brown, femora sometimes brown. Terminal abdominal segments dark brown. Body with red subintegumental pigment.

Head moderate in size, smooth dorsally and ventrally except at sides. Eyes slightly bulged from head. Ocelli absent. Postocular setae long, slightly dilated. Antennal segments III and IV slightly longer than in *hinds* and not as angular in profile, segment VIII with a pedicel that is more slender than in *ampliventralis*. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Epimeral sutures incomplete. Major prothoracic setae blunt to slightly dilated. Ventrolateral prothoracic setae seemingly pointed. Fore tarsi each with a minute tooth. Mid and hind femora without any unusual, differentiated setae. Wings reduced to tiny pads, or entirely absent.

Pelta moderately small, expanded at anterior margin. Wing-holding setae reduced. Major posterior setae on abdominal tergite IX much longer than tube, pointed. Tube about twice the length of abdominal tergite IX.

FEMALE (macropterous).—Not yet found in Illinois, unknown to me.

MALE (brachypterous).—Length distended about 1.2 mm. Similar to brachypterous female except lighter in color. Head, basal antennal segments, and legs usually entirely yellow.

Abdominal sternite VIII with a broad, bandlike glandular area. Abdominal tergite IX with lateral setae reduced in size.

Unlike its close relative, *hindsii*, *osborni* has dilated head and prothoracic setae and by these characteristics the two may be distinguished.

So far *osborni*, in its typical form, has been taken three times in Illinois. It occurs in *Andropogon* clumps as does the more common *hindsii*.

Illinois records.—ALEXANDER COUNTY: Olive Branch, February 3, 1954, Moore, 2 ♀. CLARK COUNTY: Marshall, May 13, 1949, Ross, Gloyd, Stannard, sod of *Andropogon*, 1 ♂. PIATT COUNTY: May 7, 1940, Farrar, on *Andropogon*, 3 ♀.

***Eurythrips pettiti* Hood**

Eurythrips pettiti Hood (1941:203).
♀, ♂. Type-locality.—New Market, Virginia.

FEMALE (brachypterous).—Length distended about 1.8 mm. Head, thorax, and anterior portion of pelta yellowish brown to light brown, sides of pterothorax becoming dark brown; abdominal segment I except for anterior of pelta, all of abdominal segment II, sides of abdominal segment III, and

legs yellow; remainder of abdomen dark brown. Antennae dark brown except pedicel of segment III which is yellow.

Head moderate in size (Fig. 220), median surface with small, faint gray warts, ventral surface wrinkled in anterior half and smooth in posterior half, not constricted or only slightly constricted behind eyes. Eyes just slightly bulged. Ocelli present. Postocular setae well developed, dilated. Antennal segment III with one inner and one outer sense cone, segment IV with one inner and two outer sense cones, segments VII and VIII each with moderately narrow pedicel.

Prothorax with major setae long, dilated. Epimeral sutures incomplete. Fore tarsi each with a small tooth. Mid and hind femora without any unusual, differentiated setae. Wings reduced to pads which bear two dilated setae.

Pelta derby shaped (Fig. 222). Wing-holding setae present but greatly reduced. Major posterior setae on abdominal tergite IX not extending beyond the tube, dilated.

FEMALE (macropterous).—Length distended about 2 mm. Color and structure similar to brachypterous female with the following exceptions. Eyes and ocelli larger. Wings fully developed. Wing-holding setae larger, sigmoidal, with two pairs each on abdominal tergites III–VII.

MALE (brachypterous).—Length distended nearly 1.4 mm. Similar to brachypterous female except for the following. Fore legs sometimes enlarged, tarsal tooth larger, sometimes greatly enlarged. Abdominal sternite VIII with a broad, bandlike glandular area. Abdominal tergite IX with lateral setae reduced in size, pointed.

This is a distinctive species which can be differentiated from others in Illinois by the yellow band across the basal two or three segments of the abdomen, the numerous faint gray warts on the dorsum of the head, and the shape of the pelta.

Seemingly *pettiti* is locally common in the southern two-thirds of the state. The collections of the Illinois Natural History Survey contain additional

specimens from Arkansas, Michigan, Missouri, North Carolina, and Pennsylvania.

Illinois records.—HAMILTON COUNTY: McLeansboro, November 29, 1957, Bouseman, forest litter, 1 ♀. JACKSON COUNTY: Murphysboro, November 5, 1942, Ross, Sanderson, ground litter, 2 ♀, 1 ♂; Gorham (Fountain Bluff), September 6, 1956, Smith, Stannard, forest debris, 1 ♀. JERSEY COUNTY: Pere Marquette State Park, November 20, 1958, Stannard, forest debris, 1 ♀. MARION COUNTY: Kinmundy, November 10, 1958, Evers, Clark, Stannard, forest debris, 5 ♀. MASON COUNTY: Havana, December 10, 1932, Frison, Ross, forested sand area, 1 ♀. POPE COUNTY: Herod, November 6, 1942, Ross, Sanderson, ground litter, 5 ♀, 1 ♂. VERMILION COUNTY: Danville, November 1, 1942, Ross, ground litter, 3 ♀. WOODFORD COUNTY: Goodfield, May 17, 1961, Stannard, forest debris, 4 ♀, 1 ♂.

Eurythrips setiger Stannard

Eurythrips setiger Stannard (1958a: 271). ♀. Type-locality. —Dixon Springs, Illinois.

FEMALE (macropterous).—Length distended nearly 2 mm. General color dark brown, being darkest in apical segments of antennae, thorax, and posterior segments of abdomen. Pedicel of antennal segment III yellow to yellowish brown. Legs yellowish brown, darkest in the femora. Body with red subintegumental pigment.

Head moderate in size, smooth dorsally and ventrally except at extreme sides and base. Eyes bulged from head, with a pronounced groove behind eyes. Ocelli present. Postocular setae long and dilated. Antennal segments III and IV moderate in size, not shortened; segment III with one inner and one outer sense cone; segment IV with one inner and two outer sense cones; segments VII and VIII each with a distinct pedicel. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute, other major setae well developed, dilated. Epimeral sutures complete. Major prothoracic setae di-

lated at tips. Ventrolateral metathoracic setae dilated. Fore tarsi each with a small tooth. Each femur with an unusual, differentiated, dilated seta. Fore wings fully developed.

Pelta roughly triangular, hexagonally reticulate to nearly smooth. Abdominal tergites III–VIII each with two pairs of sigmoidal wing-holding setae. Major posterior setae on abdominal tergite IX about as long as tube, pointed. Tube about twice the length of abdominal tergite IX.

FEMALE (brachypterous).—Length distended about 1.7 mm. Similar to cropterous female except head and legs slightly lighter in color. Ocelli present. Wings reduced to pads. Wing-holding setae present on abdominal tergites but slightly reduced in size.

MALE.—Unknown.

This species is separable from all others in the genus by the characteristic of the unusual, differentiated setae on each femur. It is also distinctive as being one of the few species of *Eurythrips* in which the prothoracic epimeral sutures are complete. Outside of Illinois, *setiger* is known from Arkansas and Florida (Stannard 1958a).

Illinois records.—CHAMPAIGN COUNTY: Rantoul, July 21, 1953, Evers, Stannard, prairie, 1 ♀. MONROE COUNTY: Renault, October 18, 1962, Ross, grass, 1 ♀. POPE COUNTY: Dixon Springs, August 30, 1951, Ross, Richards, sweeping vegetation, 1 ♀.

Eurythrips tarsalis Hood

Eurythrips tarsalis Hood (1925c:220). ♀. Type-locality. East Falls Church, Virginia.

Plectrothrips montanus Watson (1933b: 16). ♀, ♂. Type-locality.—Gatlinburg, Tennessee. Synonymized by Stannard (1957b).

FEMALE (apterous).—Length distended over 2 mm. General color brown to dark brown. Legs and pedicel of antennal segment III yellow to yellowish brown. Body with yellow to orange subintegumental pigment.

Head elongate, considerably prolonged beyond eyes, constricted behind eyes, smooth dorsally and ventrally. Eyes bulged. Ocelli absent or if

present greatly reduced. Postocellar and postocular setae long, pointed. Antennal segments III and IV each with one inner and two outer sense cones, segment VII with a moderately narrow pedicel, base of segment VIII broad. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Major prothoracic setae well developed, pointed to nearly pointed. Epimeral sutures incomplete. Ventrolateral metathoracic setae small, pointed. Fore legs enlarged, fore tarsi each with a well-developed tooth (Fig. 183), fore tibiae each usually with a strongly developed setal socket which protrudes at the inner apex. Mid and hind femora without any unusual, differentiated dorsal setae. Wing pads seemingly absent.

Pelta roughly triangular. Wing-holding setae reduced. Major posterior setae on abdominal tergite IX extending beyond the short tube, pointed.

FEMALE (macropterous).—Length distended over 2 mm. Similar to apterous female except legs darker (femora and basal half of tarsi brown). Ocelli present. Fore legs not greatly enlarged. Wings fully developed. Wing-holding setae small and only slightly sigmoidal, one pair each on abdominal tergites III–VII.

MALE (apterous).—Length distended about 1.8 mm. Similar to apterous female, with the following exceptions. Lighter in color, thorax yellowish brown. Abdominal sternite VIII with a moderately broad, transverse, bandlike glandular area (Fig. 55). Abdominal tergite IX with lateral setae reduced in size.

Eurythrips tarsalis is a distinctive species and may be recognized by the long head, the long postocellar setae, and the usually enlarged fore legs, each of which bears a well-developed tooth.

It occurs throughout Illinois. Besides the Illinois material, there are in the collections of the Illinois Natural History Survey specimens from Arkansas, Kentucky, Maryland, Mississippi, New York, North Carolina, Tennessee, and Virginia.

Illinois records.—Collected from April to November, from one to several localities in the following counties: CHAMPAIGN, CLARK, COOK, HENDERSON, LAWRENCE, MARION, POPE, WAYNE, WHITE, WILLIAMSON, and WOODFORD.

Eurythrips virginianus Hood

Eurythrips virginianus Hood (1952b: 77). ♀, ♂. Type-locality.—New Market, Virginia.

FEMALE (brachypterous).—Length distended over 2 mm. Color yellow to yellowish brown in head, thorax, and abdominal segment I; predominantly brown in abdominal segments II and III; yellowish brown in remainder of abdomen except sides and tube which are largely dark brown. Antennae generally yellowish brown to brown, being lightest in intermediate segments. Body with red subintegumental pigment.

Head moderate in size, smooth on the center of the dorsum and posterior part of the venter, constricted behind eyes, with a small toothlike projection behind eyes. Eyes bulged. Ocelli present. Postocular setae shorter than in *watsoni*, dilated. Antennal segment III with one inner and one outer sense cone and with two dorsal setae which are dilated or blunt, segment IV with one inner and two outer sense cones, segments VII and VIII each with a narrow pedicel. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute. Major prothoracic setae shorter than in *watsoni*, dilated. Epimeral sutures incomplete. Ventrolateral metathoracic setae small and pointed. Fore tarsi each with a small tooth. Mid and hind femora without any unusual, differentiated setae. Wings reduced to pads which usually bear two dilated setae.

Pelta broad, usually reticulate. Wing-holding setae frequently sigmoidal but reduced. Major posterior setae on abdominal tergite IX dilated.

FEMALE (macropterous).—Unknown.

MALE (brachypterous).—Length

distended about 1.5 mm. Similar to brachypterous female except for the following differences. Abdominal sternite VIII with a narrow, bandlike, subbasal glandular area. Abdominal tergite IX with lateral setae reduced in size, pointed.

Eurythrips virginianus is similar to *watsoni* in most respects. The two may be separated by the form of the dorsal setae on antennal segment III. In *virginianus* two of these dorsal setae are dilated or blunt; in *watsoni* all of these setae are pointed.

In Illinois this species is seemingly rare, but it is probably widely distributed in the state, at least along the eastern border. I also have seen specimens from Connecticut and the mountains of Tennessee. The type was collected in the Appalachians of Virginia.

Illinois records.—CLARK COUNTY: Clarksville (Rocky Branch), January 5, 1933, Frison, Ross, moss, 1 ♂. LAKE COUNTY: Volo Bog, September 2, 1951, Richards, Stannard, ground cover, and September 30, 1953, Mills, Evers, ground cover, several specimens. POPE COUNTY: Glendale, November 7, 1946, Ross, Burks, debris in pine plantation, 1 ♀.

Eurythrips watsoni Hood

Eurythrips watsoni Hood (1941:161). ♀, ♂. Type-locality.—Trenton, Florida.

FEMALE (brachypterous).—Length distended about 1.9 mm. General color yellow. Basal antennal segments yellowish brown, terminal antennal segments and tube brown. Intermediate abdominal segments usually with a brown median spot, segment IX usually brown at sides.

Head moderate in size, smooth medially on the dorsum and the venter, constricted behind eyes, with a small toothlike projection behind eyes. Eyes bulged. Ocelli present. Postocular setae long, dilated. Antennal segment III with one inner and one outer sense cone and with all setae pointed, segment IV with one inner and two outer sense cones, segments VII and VIII each with narrow pedicel. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae small. Major prothoracic setae long, dilated. Epimeral sutures incomplete. Ventrolateral metathoracic setae small and pointed. Fore tarsi each with a small tooth. Mid and hind tarsi without any unusual, differentiated setae. Wings reduced to pads which usually bear two dilated setae.

Pelta somewhat bell shaped. Wing-holding setae usually sigmoidal but reduced in size. Major posterior setae on abdominal tergite IX not extending beyond the tube, dilated.

MALE (brachypterous).—Length distended about 1.4 mm. Similar to brachypterous female except for the following. Abdominal sternite VIII with a narrow, bandlike, subbasal glandular area. Abdominal tergite IX with lateral setae reduced in size and pointed.

Unlike *virginianus*, *Eurythrips watsoni* is predominantly yellow and all of the dorsal setae on antennal segment III are pointed. Males of both these species have narrow subbasal glandular areas on abdominal sternite VIII, thereby differing from their congeners.

Originally described from Florida, *watsoni* has since been collected in North Carolina, Virginia, Kentucky, Pennsylvania, and the southern half of Illinois.

Illinois records.—FAYETTE COUNTY: Ramsey, April 7, 1954, Smith, Stannard, forest debris, 2 ♀. JOHNSON COUNTY: Buncombe, March 15, 1961, Evers, Stannard, forest debris, 1 ♀; Sanburn, September 20, 1949, Smith, Stannard, forest debris, 3 ♀, 2 ♂.

Glyptothrips Hood

Glyptothrips Hood (1912b:116). Type-species by original designation.

Glyptothrips flavescens Hood.

Head slightly longer than wide, slightly prolonged in front of eyes, completely reticulate dorsally; cheeks incised just behind eyes and without strong lateral setae. Eyes relatively small, bulged. Ocelli present in winged forms, absent in apterous forms. Postocular setae fairly short, at the most

about as long as the dorsal eye length, blunt to dilated. Antennae seven segmented to nearly eight segmented, in which case morphological segments VII and VIII partially divided by an incomplete suture; intermediate segments swollen at apex and with an abruptly narrowed pedicel; sense cones slender. Mouth cone short, broadly rounded. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae lacking or minute, remainder of major setae developed but small, with only one pair of epimeral setae. Epimeral sutures complete. Metanotum reticulate, area within reticules granulate. Praepectus present. Mesopraesternum well developed in macropterous forms known to me, degenerate in apterous forms. Macropterous, micropterous, or apterous. Fore wings when completely developed slightly outcurved beyond middle, without accessory fringe cilia. Fore tarsi armed or unarmed.

Abdomen reticulate. Pelta elongate oval or derby shaped, reticulate. Abdominal tergites with two median, longitudinal, light-colored lines. Wing-holding setae when present not expanded or leaflike. Males with a thin transverse glandular area on abdominal sternite VIII, with lateral setae on abdominal tergite IX reduced. Tube moderate in size, smooth or nearly so.

Members of this genus can be distinguished in Illinois by the bulged eyes, reticulate head, and the seven-segmented or incomplete eight-segmented antennae. I have treated *Glyptothrips* elsewhere (Stannard 1955b, 1957b).

Both of the two known species in the genus occur in our state.

KEY TO SPECIES

1. Prothoracic anterolateral setae displaced toward the meson; fore tarsi each armed with a small tooth; antennal segments VII and VIII completely fused *flavescens*
 thoracic anterolateral setae not displaced much toward the meson; fore unarmed; antennal segments VII and VIII partially divided by an incomplete suture (Fig. 159) *arkansanus*

Glyptothrips arkansanus Hood

Glyptothrips arkansanus Hood (1957: 59). ♀, ♂. Type-locality.—Stillwater, Arkansas.

FEMALE (macropterous).—Length distended about 1.6 mm. General color yellowish brown. Antennae, legs, and two median longitudinal lines on the abdominal tergites yellow. Wings pale gray, somewhat lighter in basal half.

Head hexagonally reticulate, with cheeks incised just behind eyes. Eyes small, bulged. Ocelli present. Postocular setae fully as long as eye length, blunt. Antennae incompletely eight segmented (Fig. 159), that is, morphological segments VII and VIII partially separated by an incomplete, fine suture; intermediate segments subglobose apically, each with an abruptly narrowed pedicel; sense cones slender. Mouth cone short, broadly rounded. Maxillary stylets placed far apart within the head.

Prothorax with anteromarginal setae lacking; anterolateral setae placed near the lateral angles, midlateral and posterior setae well developed, all these setae slightly longer than in *flavescens*, blunt. Epimeral sutures complete. Praepectus present. Mesopraesternum well developed. Metanotum hexagonally reticulate. Wings fully developed; fore wings slightly outcurved beyond middle, without accessory fringe cilia. Fore tarsi apparently unarmed.

Pelta derby shaped (Fig. 225). Abdomen reticulate, often with the posterior tips of the reticules drawn out into a spicule. Wing-holding setae developed, sigmoidal. Abdominal tergite IX with median setae blunt, lateral setae shorter than in *flavescens*, pointed. Tube moderate in size, nearly smooth.

MALE (micropterous).—Length distended about 1.4 mm. General color



Fig. 225.—*Glyptothrips arkansas*, ♀ macropterous, pelta.

and structure similar to macropterous female except for the following. Wing pads extending to the second abdominal segment. Abdominal sternite VIII with a thin, median, transverse glandular area. Abdominal tergite IX with major lateral setae reduced in size.

This species has been known to me for many years prior to its formal description. Although I listed its characteristics in 1955, I hesitated to name it then because I was unable to compare all its features with those of the macropterous form of *flavescens*. According to Hood (1957), the characteristics mentioned in the foregoing key will separate the two species, irrespective of the form.

As is *flavescens*, *arkansanus* is probably statewide in distribution, and the two are frequently found together in grass clumps, particularly *Andropogon*.

Illinois records.—CHAMPAIGN COUNTY: Seymour, February 28, 1936, Farrar, under rye grass, 4 ♀. COLES COUNTY: Mattoon, May 14, 1933, Mohr, grass sod, 1 ♀, 1 ♂. COOK COUNTY: near Elgin, Shoefactory Road prairie, October 10, 1952, Ross, Stannard, sod of *Andropogon*, 5 ♂. DE WITT COUNTY: Farmer City, November 6, 1953, Smith, Stannard, sod of *Andropogon*, 2 ♀. IROQUOIS COUNTY: Milford, October 21-25, 1962, McCollum, Roberts, sod of *Andropogon*, 3 ♂. PIATT COUNTY: Mansfield, February 28, 1936, Farrar, sod of *Andropogon*, 2 ♀; Monticello, December 2, 1937, September 22, 1938, March 17, 1939, January 12, 1939, January 23, 1942, Farrar, sod of *Andropogon*, 5 ♀, ♂.

Glyptothrips flavescens Hood

Glyptothrips flavescens Hood (1912b: 116). ♀. Type-locality.—Grand Tower, Illinois.

FEMALE (apterous) (Fig. 226).—Length distended about 2 mm. General color yellowish brown with head, antennal segments I and II and pedicels of remaining segments, two mesal longitudinal lines on the abdominal tergites, and the terminal abdominal segments grading into yellow. Antennal segments III to morphological seg-

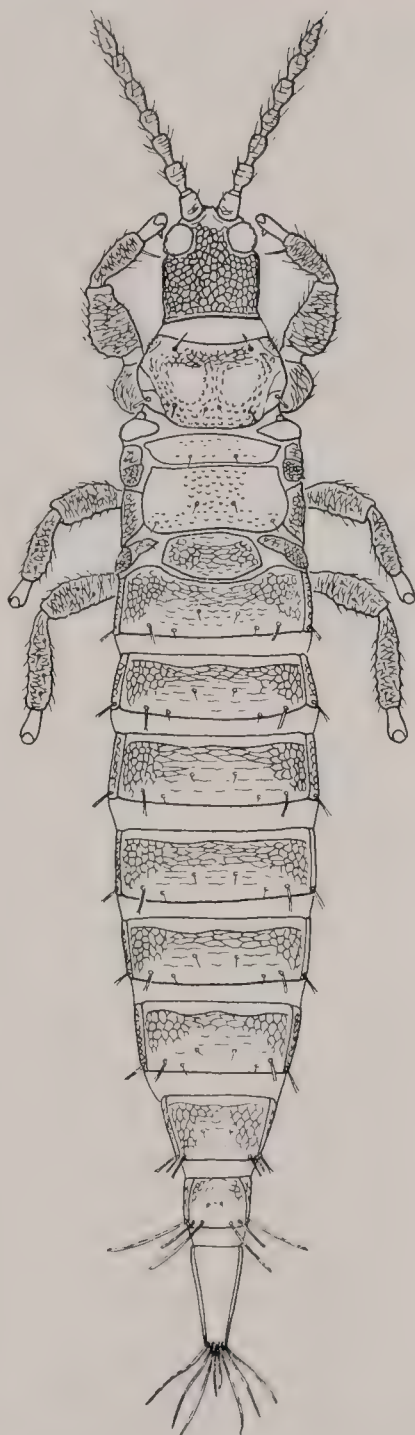


Fig. 226. *Glyptothrips flavescens*, dorsal aspect.

ments VII and VIII, except pedicels, brown. Body with orange-red subintegumental pigment.

Head hexagonally reticulate, with cheeks incised just behind eyes. Ocelli absent. Postocular setae small, much smaller than eye length, dilated. Antennae seven segmented, morphological segments VII and VIII completely fused, intermediate segments subglobose apically, each with abruptly narrowed pedicel; sense cones slender, almost setae-like. Mouth cone short, broadly rounded. Maxillary stylets placed far apart within head.

Prothorax with anteromarginal setae minute or lacking; anterolateral setae displaced slightly towards the meson, midlateral and posterior setae developed, all these setae short and blunt to dilated. Epimeral sutures complete. Praepectus present. Mesoprae-sternum degenerate. Metanotum hexagonally reticulate. Wings entirely absent. Fore tarsi each armed with a small tooth.

Pelta rectangular to elongate oval, reticulate (Fig. 227). Abdomen reticulate, often with the posterior tips of the reticules drawn out into a spicule. Wing-holding setae not developed. Abdominal tergite IX with median setae dilated, lateral setae longer than in *arkansanus*, pointed. Tube moderately long, smooth.

FEMALE (macropterous).—Described by Hood (1912*b*) as lacking accessory fringe cilia on fore wings and possessing ocelli; in many other features similar to apterous female. Descriptions of pelta, mesopraesternum, and praepectus not given by the protologist.

MALE (apterous).—Length distended about 1.6 mm. Similar in general color and structure to apterous female. Abdominal sternite VIII with a thin, median, transverse glandular area. Abdominal tergite IX with major lateral setae reduced in size.

This species differs from *arkansanus* by the characteristics mentioned in the foregoing key. In addition the apterous form, at least, differs from the winged form of *arkansanus* by the shape of the pelta.

Apparently *flavescens* occurs



Fig. 227.—*Glyptothrips flavescens*, ♀ apterous, pelta.

throughout Illinois in grasslands, particularly in *Andropogon* clumps.

Illinois records.—ALEXANDER COUNTY: east of Cape Girardeau, January 12, 1965, McCollum, Shaw, Stannard, in Johnson grass, 10 specimens. DE WITT COUNTY: Farmer City, November 6, 1953, Smith, Stannard, sod of *Andropogon*, 2 ♀, 2 ♂. DOUGLAS COUNTY: Arcola, October 12, 1949, Stannard, grass sod, 5 ♂. JACKSON COUNTY: Grand Tower (Hood 1912). MARSHALL COUNTY: Lacon, June 5, 1933, Mohr, grass, 1 ♀. PIATT COUNTY: Monticello, December 2, 1937, February 21, 1938, May 3, 1938, March 17, 1939, Farrar, on *Andropogon*, 7 ♀, 5 ♂. PULASKI COUNTY: Pulaski (Hood 1912). STEPHENSON COUNTY: Freeport, June 3, 1933, Ross, Townsend, grass sod, 1 ♀.

Gnophothrips Hood and Williams

Gnophothrips Hood and Williams (1915:133). Type-species by original designation.—*Gnophothrips megaceps* Hood and Williams.

Head longer than wide, slightly arched medially, with anastomosing transverse striae, cheeks nearly straight without strong bristles, vertex slightly produced. Ocelli present, somewhat reduced in micropterous forms. Eyes moderate in size. Postocular setae shorter than eye length, blunt. Antennae eight segmented, inserted just under fore margin of head, segments III and IV with short sense cones, segment VIII nonpedicellate, fairly closely joined to segment VII. Mouth cone broadly rounded. Maxillary stylets, when at rest, extended far into the head, up to the region of the eyes.

Pronotum shorter than head, with weak transverse striations laterally. All major prothoracic setae present

but relatively short, blunt to dilated. Epimeral sutures complete. Praepectus absent. Macropterous or micropterous. Fore wings short, only about $2\frac{1}{2}$ times as long as head, lacking accessory fringe cilia; wing stubs in micropterous form nearly equal in length to head. Fore legs unarmed.

Abdominal tergites weakly sculptured with anastomosing, transverse striae. Pelta more or less triangular, blunt anteriorly. Abdominal tergites II–VII each with two pairs of wing-holding setae. Abdominal sternite VIII of male apparently without glandular area. Abdominal tergite IX with major posterior setae shorter than tube, pointed; lateral pair in male reduced and spinelike. Tube over half as long as head; anal setae just slightly shorter than tube.

This genus resembles *Liothrips* subgenus *Rhynchothrips*. It differs from *Rhynchothrips* in having a proportionately longer head, in the absence of accessory fringe cilia on the fore wings of the macropterous form, and in the characteristic of the relatively long wing pads in the flightless form.

Although three specific names have been proposed, two are synonyms and the genus remains monobasic.

Gnophothrips fuscus Morgan

Trichothrips fuscus Morgan (1913:30).

♀. Type-locality.—Quincy, Florida. Transferred to *Liothrips* by Hood (1918). Transferred to *Gnophothrips* by O'Neill (1965).

Gnophothrips megaceps Hood and Williams (1915:133). ♀. Type-locality.—Emeralda, Florida. New synonymy.

Gnophothrips piniphilus J. C. Crawford (1938:39). ♀, ♂. Type-locality.—Patchague, Long Island, New York. Synonymized by O'Neill (1965).

FEMALE (macropterous).—Length distended nearly 2.3 mm. General color dark brown with antennal segment III yellow, segments IV–VI yellow basally and yellowish brown apically, segment VII yellow in the pedicel, remainder of antennae yellowish brown.

Head nearly $1\frac{1}{2}$ times as long as wide. Anterior ocellus projecting beyond anterior eye margin. Eyes not bulged. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones, segment VIII nonpedicellate, distinctly narrower at base than apex of segment VII.

Prothorax about two-thirds as long as head. All major prothoracic setae present, short, dilated. Metanotum with well-marked longitudinal striae. Fore wings not narrowed in middle, with three short basal setae which are blunt to dilated. Fore legs unarmed.

Abdomen with segments relatively short and wide. Pelta more or less triangular. Anterior wing-holding setae C-shaped; posterior wing-holding setae sigmoidal. Tube nearly two-thirds as long as head; anal setae almost as long as head.

FEMALE (micropterous).—Length distended nearly 2.2 mm. Similar in structure and color to macropterous form.

MALE (micropterous).—Length distended nearly 1.8 mm. Similar in color and structure to female. Abdominal tergite IX with major lateral setae shortened and spinelike, light brown in color.

When Crawford described *piniphilus*, the holotype of *megaceps* was not available to him for comparison. Seemingly from the literature alone, *piniphilus* was distinct in having a longer head and darker antennae, in having antennal segment VIII not as broadly joined to VII, and in a few other minor features. Now, after studying all the types, it is apparent to me that *piniphilus*, *megaceps*, and *fuscus* represent the same species, and purported differences lie well within the range of expected intraspecific variation. From the arrangement of the slides in the Hood collection, it would seem that Hood knew of or suspected this synonymy, and that when C. Jacot-Guillarmod noticed this arrangement in examining the Hood collection in 1963, he also became cognizant of the synonyms involved (see O'Neill 1965).

The species *fuscus* feeds on introduced as well as native pines (Lind-

quist and Harnden 1957), causing economic damage in some cases. So far this species has not been found outside the eastern seaboard states. It might be found in Illinois in the future on imported nursery stock.

Haplothrips Amyot and Serville

Based on the representatives of this genus known to me from Illinois and elsewhere, the segregation of subgenera is not only difficult but also of doubtful value. The extremes of each of these segregates are sufficiently distinct to warrant their assignment to full genera, but between them are intermediates which so closely bind the subgenera together that no clear-cut division can be made. There is on the one hand the slender, degenerate *Karnyothrips* which intergrades into the generalized *Haplothrips* s. str. and on the other hand the specialized, long-headed *malifloris* complex and *Leptothrips* which also intergrade back into the nominate subgenus. Because of custom, however, and not because of any special need, the following intergrading subgenera are diagnosed separately. For convenience the species are keyed in the same key and are placed one after the other alphabetically regardless of their subgeneric grouping to help avoid the confusion that always arises when superspecific categories cannot be defined precisely.

Eleven species of this polymorphic genus occur in our state.

Haplothrips Amyot and Serville s. str.

Haplothrips Amyot and Serville (1843: 640). Type-species by monotypy.—*Phloeothrips albipennis* Burmeister (= *Thrips aculeata* Fabricius).

Anthothrips Uzel (1895:237). Type-species by subsequent designation by Priesner (1949).—*Thrips aculeata* Fabricius. Synonymized by Karny (1912b).

Zygothrips Uzel (1895:243). Type-species by monotypy.—*Zygothrips minuta* Uzel. Synonymized by Priesner (1949).

Anthemothrips Karny (1907:51). Type-species by monotypy.—*Anthemo-*

thrips reuteri Karny. Synonymized by Priesner (1949).

Hindsiana Karny (1910:51). Type-species by monotypy.—*Hindsiana flavicincta* Karny. Synonymized by Priesner (1949).

Porphyrothrips Vuillet (1913:78). Type-species by original designation.—*Porphyrothrips cottei* Vuillet. Synonymized by Priesner (1949).

Haplothrips Bagnall (1934:495). Type-species by original designation.—*Haplothrips globiceps* Bagnall. Synonymized by Priesner (1949).

Head about as long as wide to longer than wide, surface of head weakly transversely striate. Eyes moderate in size, never prolonged ventrally more than dorsally. Ocelli present, fore ocelli often protruding anteriorly of head. Postocular setae minute to moderate in size, usually pointed. Cheeks relatively smooth without strong lateral setae. Antennae eight segmented; segment III usually asymmetrical, generally smaller than segment IV, with none, one, or two apical sense cones; segment IV with four apical sense cones; segment VIII usually nonpedicellate, broadly attached to segment VII. Mouth cone short and broad to longer and pointed or nearly pointed. Maxillary stylets retracted far into the head, frequently widely spread within the center of the head. Maxillary bridge conspicuous, ordinarily wide.

Thorax more robust than in the subgenus *Karnyothrips*. Prothorax at the most weakly sculptured; with major anterior setae usually much shorter than major posterior setae, frequently anteromarginal and lateral setae small to minute, in Illinois all of these setae pointed to blunt. Epimeral sutures complete. Praepectal plates usually present. Metanotum, in Illinois species, weakly sculptured so as to appear almost smooth. All species in Illinois macropterous. Fore wings usually slightly constricted in the middle, with or without accessory setae. Fore femora and tibiae unarmed, fore tarsi each always with an inner tooth in species of our local fauna.

Pelta triangular, sometimes strongly sculptured. Wing-holding setae well developed, sigmoidal. Major posterior setae on abdominal tergite IX pointed, in males the lateral pair being much reduced in size. Males apparently without a distinct glandular area on abdominal sternite VIII. Females with a small or large internal rod (fustis) in abdominal segment IX. Tube moderate to relatively short in size; terminal setae not greatly elongated.

Members of this, the nominate subgenus, are distinguishable in Illinois from the subgenus *Leptothrips* by not having the eyes prolonged ventrally more than dorsally and not having strong longitudinal striae on the metanotum, from the subgenus *Karnyothrips* by being more robust and often by not having the major prothoracic setae dilated, and from the subgenus *Neoheegeria* by having shorter setae on the head and pronotum.

So far, six species have been found in Illinois. Two of these are probably introduced: *leucanthemi* from Europe, supposedly having come here in pioneer times, and *malifloris* from western United States, supposedly having come here since the advent of the railroad, when many plants and some insects swept eastward via the well-drained cinder ballast.

Haplothrips subgenus *Karnyothrips* (Watson)

Dolichothrips Watson (1920:21). Type-species by original designation.—*Cephalothrips elongata* Watson. Preoccupied by *Dolichothrips* Karny (1912c).

Karynia [sic] Watson (1922a:6). Type-species by original designation.—*Karynia weigeli* Watson (= *Anthothrips flavipes* Jones). Misspelling for *Karnyia*; preoccupied by *Karnyia* Shelford (1909).

Watsoniella Karny (1923:367). New name for *Dolichothrips* Watson; preoccupied by *Watsoniella* Berg.

Karnyothrips Watson (1924a:23). New name for *Karnyia* Watson; subordinated to *Haplothrips* by Stannard (1957b).

Haplothrips subgenus *Xylaplothrips* Priesner (1928:572). Type-species by monotypy.—*Cryptothrips fuliginosus* Schille. Synonymized by Stannard (1957b).

In reference to the Illinois fauna only, the members of this subgenus are similar to those in the nominate subgenus except for the following characteristics. Generally more slenderly formed than *Haplothrips* s. str. Head with surface so weakly striate as to appear smooth or nearly smooth. Ocelli small, sometimes absent in the brachypterous form. Postocular setae always moderate in size, blunt to dilated, never pointed. Antennal segment III usually symmetrical, with one or two apical sense cones. Prothorax not as wide as in *Haplothrips* s. str. Major prothoracic setae, particularly posterior pairs, usually distinctly dilated. Macropterous or brachypterous. Fore tarsi unarmed or each armed with a small tooth.

Abdomen with wing-holding setae well developed or not differentiated. Males with or without a distinct glandular area on abdominal sternite VIII. Female always with a small internal rod (fustis) in abdominal segment IX. Terminal setae of tube always considerably elongate.

As is obvious from the synonymy, much difficulty was encountered in choosing an acceptable name for this taxon. Three of the names proposed were later found to be preoccupied, one being a substitute for a previously preoccupied name. *Zygothrips*, with *minutus* as the type, was used for many years until 1939 when Priesner concluded that *minutus* was a true *Haplothrips* belonging to the *subtilissimus* group. At the suggestion of Hood (1949) *Watsoniella* was favored over *Karnyothrips* for a brief period until 1951 at which time Cott (personal communication) discovered that it too was unavailable and once again *Karnyothrips* became the proper name.

Because this subgenus so closely resembles *Haplothrips* s. str. the species of the two subgenera are included together in the key.

Three species have been taken in

Illinois. Two of them, *harti* and *longiceps*, live in grasslands, and *americanus* lives in forests.

Haplothrips subgenus *Leptothrips* Hood

Leptothrips Hood (1909b:249). Type-species by original designation.—*Cryptothrips aspersus* Hinds (= *Phloeothrips mali* Fitch). Also proposed in 1909 by Bagnall but attributed to Hood, the precise date of publication of either paper unknown to me. Subordinated to *Haplothrips* by Stannard (1957b).

The members of this subgenus are similar to the *malifloris* complex of the nominate subgenus except, in Illinois and sometimes elsewhere, for the following characteristics. Generally dark purple in life. Eyes in the female prolonged posteriorly on the ventral surface of the head more than on the dorsal surface. Maxillary stylets placed fairly far apart when retracted within the head. Prothorax with major lateral setae minute. Metanotum strongly longitudinally striate, a condition also found in species of other complexes occurring outside of Illinois. Fore tarsi unarmed. Fore wings with accessory fringe cilia present, as also sometimes is the case in out-of-state species of other complexes. Abdominal segment IX of female with internal rod (*fustis*) not enlarged.

Although there may be little need to keep *Leptothrips* as a separate entity, it has been done so here for the sake of custom and tradition. According to Cott (1956) no member of *Leptothrips* in North America has the fore tarsi armed with teeth, whereas all members of the nominate subgenus in our continent do have such teeth. The great number of similarities between these two entities, however, reduced the significance of the presence or absence of fore tarsal teeth. Because *Leptothrips* is a taxon of such closely related species it is in essence hardly more than a species group of the *malifloris* complex.

The single species which occurs in Illinois, *mali*, is keyed with all the other members of *Haplothrips*.

Haplothrips subgenus *Neoheegeria* Schmutz

Neoheegeria Schmutz (1909b:344). Type-species by monotypy.—*Neoheegeria dalmatica* Schmutz. Subordinated to *Haplothrips* by Stannard (1957b).

As represented in Illinois, this subgenus is very similar to those in the nominate subgenus, differing only by a combination of specific characteristics and not by any one or several major points. In the Old World some species of *Neoheegeria* have the fore wings expanded apically more than is typical of *Haplothrips* s. str. In general, species of *Neoheegeria* have the head and prothoracic setae extremely long although occasionally similar conditions appear in exotic species of true *Haplothrips* and, as a consequence, the retention of the segregate, *Neoheegeria*, is unnecessary except to conform to convention.

Only the introduced species, *verbasci*, is present in the fauna of Illinois.

KEY TO SPECIES (ILLINOIS, EXCEPT WHERE NOTED)

1. Eyes prolonged posteriorly on the ventral surface of the head more than on the dorsal surface (Fig. 228); metanotum strongly longitudinally striate; generally dark purple in life. *Haplothrips (Leptothrips) mali*
Eyes not prolonged posteriorly on the ventral surface of the head more than on the dorsal surface; metanotum weakly sculptured to smooth; generally dark brown to nearly black in life. 2
2. Postocular and prothoracic setae extremely long. *Haplothrips (Neoheegeria) verbasci*
Postocular and prothoracic setae shorter. 3
3. Tibiae yellow. *Haplothrips (Karnyothrips) longiceps*
Tibiae, at least mid and hind pairs, predominantly dark brown. 4
4. All tarsi yellow; antennal segment III apparently without sense cones; on *Spartina*. *Haplothrips (Haplothrips) shackelfordae*
Mid and hind tarsi, at least, light or dark brown; antennal segment III always with an outer sense cone, sometimes also with an inner sense cone; on other hosts. 5
5. Fore wings without accessory fringe cilia. 6
Fore wings with three to eight accessory fringe cilia, or brachypterous. 7

6. Maxillary stylets placed fairly close together within head; females with fustis (internal rod of abdominal segment IX) large.
 Haplothrips (Haplothrips) malifloris
 Maxillary stylets placed fairly far apart; females with fustis short.
 Haplothrips (Karnyothrips) harti
7. Anteromarginal setae of prothorax well developed; macropterous or brachypterous; under bark.
 Haplothrips (Karnyothrips) americanus
 Anteromarginal setae of prothorax minute; always macropterous; on flowers, grasses or sedges, trees or shrubs. 8
8. Antennal segment III with one inner and one outer sense cone; segment VII with pedicel just slightly wider than pedicel of segment VI; postocular setae minute; on flowers of yarrow, daisy, and red clover
 Haplothrips (Haplothrips) leucanthemi
 Antennal segment III with one outer sense cone only; segment VII with pedicel nearly equal to or much wider than pedicel of segment VI; postocular setae, if small, not minute; on other hosts. 9
9. Abdominal tergite IX with major posterior setae very long, exceeding tube; on *Vaccinium*; not yet found in Illinois.
 Haplothrips (Haplothrips) rectipennis
 Abdominal tergite IX with major posterior setae shorter, not extending beyond tube. 10
10. Antennal segments III–VI yellow to yellowish brown
 Haplothrips (Haplothrips) subtilissimus
 Antennal segments (except III) mostly brown. 11
11. Pores on pelta usually closer to each other than either is from lateral margin of pelta; body setae relatively short; on *Scirpus*.
 Haplothrips (Haplothrips) ha'ophilus
 Pores on pelta usually spaced farther from each other than either is from lateral margin of pelta; body setae longer; host unknown.
 Haplothrips (Haplothrips) graminis

Haplothrips (Karnyothrips) americanus (Hood)

Zygothrips americanus Hood (1912b: 114). ♀, ♂. Type-locality.—Urbana, Illinois.
Cephalothrips elegans Moulton (1929b: 236). ♀. Type-locality.—Clarks-ville, Tennessee. Synonymized by Hood (1957).

FEMALE (brachypterous).—Length distended about 1.8 mm. Color dark brown except antennal segment III and all tarsi which are light brown to yellowish brown. Body with red sub-integumental pigment.

Head slightly longer than wide, nearly smooth. Eyes moderately small. Fore ocellus often absent, hind ocelli present but small. Postocular setae moderate in size, blunt to dilated. Antennal segment III with one outer and one inner sense cone; segment VIII nonpedicellate, broadly attached to segment VII. Mouth cone moderate in size, broadly rounded. Maxillary stylets placed fairly far apart within head; maxillary bridge broad.

Prothorax with anteromarginal and lateral setae well developed, as stout as and as long as or longer than anterolateral setae; major posterior setae longer than the rest and more dilated. Praepectus present. Metanotum smooth. Fore tarsi each armed with a minute tooth. Wings reduced to pads.

Pelta roughly triangular, broad at base and short, pores placed far apart. Abdominal tergite II nearly smooth. Abdominal tergites often with sublateral setae blunt. Wing-holding setae not differentiated. Abdominal tergite IX with major posterior setae extremely long, pointed. Fustis short. Tube moderately short, with long terminal setae.

FEMALE (macropterous).—Length distended about 1.8 mm. Similar in most respects to brachypterous female with following exceptions. Body setae, especially postocular setae and major setae of prothorax, longer. Fore ocellus always present. Wings well developed, clouded with light brown; fore wings slightly constricted in the middle, with three to five accessory fringe cilia. Wing-holding setae on abdomen well developed, sigmoidal.

MALE (brachypterous).—Length distended about 1.2 mm. In general similar to brachypterous female with the following exceptions. Apical half of tibiae and all tarsi tending to be more yellowish brown. Abdominal tergite IX with major lateral setae greatly reduced. Abdominal sternite VIII without a distinguishable glandular area.

This species is closely related to the western *sonorensis* which does not occur in our fauna. In Illinois *americanus* may be separated from *harti*, which it resembles superficially, by

the characteristics enumerated in the key and in the discussion of *harti*.

Throughout our state, *americanus* is common on branches of trees and shrubs, particularly around fungi on dead branches. Possibly it preys on larvae mites (Snetzinger 1960).

Illinois records.—Present every month of year, collected from one to several localities in the following counties: ADAMS, ALEXANDER, CHAMPAIGN, CLARK, COOK, CUMBERLAND, DE WITT, EDGAR, EFFINGHAM, FULTON, HARDIN, HENRY, JACKSON, JEFFERSON, JOHNSON, KANKAKEE, LAKE, LA SALLE, MACON, MACOUPIN, MENARD, MONROE, OGLE, PIATT, POPE, PULASKI, PUTNAM, RANDOLPH, SCHUYLER, TAZEWELL, UNION, VERMILION, WASHINGTON, and WHITE.

Haplothrips (Haplothrips) graminis Hood

Haplothrips graminis Hood (1912a: 69). ♀, ♂. Type-locality.—Brownsville, Texas.

Anthothrips floridensis Watson (1916: 128). ♀. Type-locality.—Gainesville, Florida. Synonymized by Watson (1920).

Haplothrips querci Watson (1920:28). ♀, ♂. Type-locality.—Daytona Beach, Florida. Synonymized by Hood (1927b).

Haplothrips rabuni Watson (1922c:37). ♀. Type-locality.—Clayton, Rabun County, Georgia. Synonymized by Hood (1927b).

Haplothrips angusticeps Watson (1922c:38). ♂ (see explanation in the following discussion). Type-locality.—Clayton, Rabun County, Georgia. New synonymy.

FEMALE (macropterous).—Length distended about 2.3 mm. Color dark brown except apex of each of the fore tibiae, fore tarsi, and basal half of antennal segment III, which are yellowish brown. Wings colorless except for light brown bases of fore wings. Body with red subintegumental pigment.

Head longer than wide, anterior area not particularly prolonged, dorsal surface weakly transversely striate. Eyes moderate in size, not prolonged ventrally more than dorsally. Ocelli

present. Postocular setae moderate in size, pointed. Antennal segment III with one outer sense cone, segment IV with two outer and two inner sense cones, segment VII with a broad pedicel, segment VIII nonpedicellate. Mouth cone relatively short, broadly rounded. Maxillary stylets placed fairly far apart within the head, maxillary bridge broad.

Prothorax with anteromarginal setae minute, lateral setae small, anterolateral setae longer than in *halophilus*, all pointed to blunt. Praepectus present. Metanotum weakly sculptured. Fore tarsi each armed with a short tooth. Fore wings slightly constricted in the middle; setae on basal vein spur nearly equal in length, moderately small, basal two blunt, apical setae pointed; each with eight accessory cilia.

Pelta triangular but not as slender as in *halophilus*, with distinct sculpture in the form of elongate hexagonal reticulations; pores usually farther apart than either is from the lateral margin. Abdominal tergite IX with major posterior setae moderately long, pointed. Abdominal segment IX with internal rod (fustis) short. Tube moderately short.

MALES.—Not yet taken in Illinois. Reported to be similar to female except fore tarsal tooth larger, abdominal tergite IX with major lateral posterior setae reduced, pointed. Abdominal sternite VIII apparently without any definite glandular area.

This species is very similar to *halophilus* but differs in having longer body setae and having the pores on the pelta placed farther apart from each other than both are from the lateral margins of the pelta. I have seen specimens from Arkansas which show some intergradation with *halophilus* in the characteristics mentioned, and because of this it would be advisable to re-examine the two species when sufficient material is collected to determine their exact status.

Because the holotypes of the synonyms are either missing or there may be some question as to their identity, the following designations and comments seem to be required.

Anthothrips floridensis.—After the protolog, Watson stated that the holotype was deposited in the American Museum of Natural History and that the paratypes were retained in the Watson collection. I have been unable to find this holotype. There are, however, in the Watson collection five slides labelled "types, thrips on corn, Sta. farms, April 22, 1914." These are probably the paratypes kept by Watson. All have the characteristics of *graminis*.

Haplothrips querci.—In the Watson collection there are two slides in the type series from "Daytona Beach, August 30, 1919, J. R. W., on scrub oak." The specimens involved are males despite the label "♀" on one slide. Neither slide is marked "holotype." Because Watson wrote that he was describing a female in the protolog and because Hood (1927b) indicated that he had examined the holotype, there is a possibility that a holotype female did or does exist elsewhere. The males in the type series still present in the Watson collection have the characteristics of *graminis*.

Haplothrips rabuni.—Only one slide remains in the type trays of the Watson collection. It is marked "type, Clayton, Georgia, September 2, 1922, J. R. W. Coll., on grass along stream." Previously the phrase "para" had preceded "type" but now the former phrase is crossed out. This slide contains a well-mounted macropterous female with typical characteristics of *graminis*. Hood (1927b) indicated that he had seen the "holotype" which presumably could have been this specimen. To erase any uncertainty of the identity of *rabuni* the afore-mentioned specimen is here designated as the lectotype.

Haplothrips angusticeps.—There are two slides labeled as this species in the type trays of the Watson collection. Both are males, not females as stated by Watson in the protolog. To avoid confusion, a lectotype is here designated to be the slide marked "type ♂, Clayton, Georgia, Aug. 29, '22, J. R. W., swale grass & smartweed." The specimen is mounted venter side up and has the characteristics of *graminis*.

Haplothrips graminis is found in the southeastern part of the United States and extends into Illinois only in the extreme south. Except that it is an inhabitant of grasslands, nothing is known of its life history.

Illinois records.—ALEXANDER COUNTY: Roth, July 15, 1954, Ross, Stannard, grass, 1 ♀; east of Cape Girardeau, January 12, 1965, McCollum, Shaw, Stannard, Johnson grass, 1 ♀. JOHNSON COUNTY: Goreville, June 21, 1950, Sanderson, prairie, 1 ♀. PULASKI COUNTY: Mounds, August 26, 1953, Sanderson, Moore, sweeping grass, 3 ♀. SALINE COUNTY: Texas City, July 17, 1962, Evers, Stannard, Johnson grass, 5 ♀, 1 ♂.

Haplothrips (Haplothrips) halophilus Hood

Haplothrips halophilus Hood (1915a: 29). ♀, ♂. Type-locality.—Bountiful, Utah.

FEMALE (macropterous).—Length distended about 2.3 mm. General color dark brown except apex of each of the fore tibiae, fore tarsi, and basal half of antennal segment III which are yellowish brown. Wings colorless except for bases of fore wings which are light brown. Body with red subintegumental pigment.

Head longer than wide, anterior area not particularly prolonged, dorsal surface weakly transversely striate. Eyes moderate in size, not prolonged ventrally more than dorsally. Ocelli present. Postocular setae moderately short but not minute as in *leucanthemi*, pointed. Antennal segment III with one outer sense cone, segment IV with two outer and two inner sense cones, segment VII with a broad pedicel, segment VIII nonpedicellate. Mouth cone relatively short, broadly rounded. Maxillary stylets placed fairly far apart within the head, maxillary bridge broad.

Prothorax with anteromarginal and lateral setae minute, anterolateral setae small, major posterior setae larger and blunt at tips. Praepectus present. Metanotum weakly reticulate. Fore tarsi each armed with a short, stout tooth. Fore wings slightly constricted

in the middle; setae on basal vein spur nearly equal in length, small, basal two blunt, apical setae pointed; each with seven or eight accessory setae.

Pelta triangular with distinct sculpture in the form of elongate hexagonal reticulations; pores usually closer to each other than either is from lateral margin. Abdominal tergite IX with major posterior setae moderate in size, pointed. Abdominal segment IX with internal rod (fustis) moderate in size. Tube moderately short.

MALE (macropterous).—Length distended about 1.8 mm. Similar to female in color and structure with the following exceptions. Fore legs sometimes slightly enlarged, fore tarsal tooth larger. Abdominal tergite IX with major lateral posterior setae reduced in size. Abdominal sternite VIII apparently without any definite glandular area.

Haplothrips halophilus is most similar to *graminis*, differing principally in the characteristics mentioned in the key. It hardly seems to be closely related to *fasciculatus* (= *jonesii*) as contended by Hood (1915a) and Cott (1956). The species *fasciculatus* belongs to the group containing *malifloris* whose members bear a large rod or fustis and usually lack praepectal plates and accessory fore wing fringe cilia.

This species has a wide range, being found in the West from Washington to Utah south to California, New Mexico, Arizona, and Texas, thence east to North Dakota and Illinois. Our Illinois records are solely from Lake County.

Illinois records.—LAKE COUNTY: Antioch, September 13, 1951, Richards, Stannard, on *Scirpus*, 2 ♀, 3 ♂; Zion (Beach State Park), August 30, 1955, Moore, Stannard, on *Juncus* 1 ♀.

Haplothrips* (*Karnyothrips*) *harti (Hood)

Zygothrips harti Hood (1913b, June: 162). ♀, ♂. Type-locality.—Loma, Texas. Transferred to *Haplothrips* by Stannard (1957b).

Zygothrips femoralis Morgan (1913, August: 40). ♀. Type-locality.—

Clarksville, Tennessee. Synonymized by Hood (1917).

Haplothrips gracilis Watson (1920:18). ♀. Type-locality.—Gainesville, Florida. New synonymy.

FEMALE (macropterous).—Length distended about 1.6 mm. Color dark brown except antennal segment III, apex of each of the fore tibiae, and all tarsi which are light brown to yellowish brown. Wings colorless except for a light brown cloud at extreme base of fore wings. Body with much red sub-integumental pigment.

Head slightly longer than wide, smooth. Eyes moderate in size. Ocelli present. Postocular setae moderate in size, blunt to dilated. Antennal segment III with one outer and one inner sense cone; segment VIII slightly narrowed at base, not as broadly attached to segment VII as in *americanus*. Mouth cone moderate in size, broadly rounded. Maxillary stylets placed far apart within head, maxillary bridge broad.

Prothorax with anteromarginal and lateral setae minute, slender; anterolateral setae relatively small, blunt; major posterior setae moderately long, slightly dilated. Praepectus present. Metanotum nearly smooth. Fore tarsi apparently unarmed. Fore wings narrow, hardly at all constricted in the middle, without accessory fringe cilia.

Pelta triangular, more narrowed than in *americanus*; pores placed far apart. Abdominal tergite II with faint scallop-like markings. Abdominal tergites often with sublateral setae dilated. Wing-holding setae well developed, sigmoidal. Abdominal tergite IX with major posterior setae moderately long, mid pair blunt to dilated, lateral setae pointed. Fustis short. Tube moderately small, with long terminal setae.

MALE (macropterous).—Length distended usually less than 1.4 mm. Similar to female in general color and structure with the following exceptions. Abdominal sternite VIII with a broad, transverse glandular area. Abdominal tergite IX with major lateral posterior setae reduced.

In general appearance, this species resembles *americanus*, but the two

may be easily distinguished on the basis of a number of characteristics. For example, *americanus* possesses well-developed anteromarginal setae and accessory fringe cilia on the fore wings and lacks a definite glandular area in the male. By contrast *harti* has the anteromarginal setae greatly reduced, lacks accessory fringe cilia on the fore wings, and possesses a large, distinct glandular area in the male.

Although not frequently encountered, *harti* has been taken throughout our state on herbs and grasses, especially in or near open fields. It occurs in many eastern states, particularly those in the southeast, and west to Texas and Arkansas (INHS records).

Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 8, 1951, Richards, Stannard, grass, 1 ♀, 1 ♂. CLARK COUNTY: Marshall, May 13, 1949, Ross, Stannard, Gloyd, sweeping vegetation, 1 ♂. JACKSON COUNTY: Makanda, July 14, 1948, Sanderson, Stannard, sweeping vegetation in woods, 1 ♀; Vergennes, August 15, 1951, Ross, Stannard, 1 ♂. LAWRENCE COUNTY: Lawrenceville, August 7, 1953, Smith, Moore, Stannard, on *Andropogon*, 1 ♂. OGLE COUNTY: Oregon, September 15, 1955, Ross, Stannard, on *Andropogon*, 1 ♀. PIKE COUNTY: Kinderhook, August 9, 1951, Richards, Stannard, on willow, 1 ♂. POPE COUNTY: Eddyville (Lusk Creek Canyon), July 18, 1962, Evers, Stannard, hill prairie, 1 ♀. WAYNE COUNTY: Mt. Erie, August 26, 1964, Faatz, Stannard, sweeping grass, 1 ♀.

Haplothrips (Haplothrips) leucanthemi (Schrank)

Thrips leucanthemi Schrank (1781: 298). ? ♀. Type-locality.—?Austria. Transferred to *Haplothrips* by Priesner (1920a).

?*Phloeothrips nigra* Osborn (1883:154). ? ♀. Type-locality.—Ames, Iowa. Synonymized by Watson (1924a). Possibly this is a distinct species, however.

Zygothrips wyomingensis Watson (1924a:82). ♀. Type-locality.—Dayton, Wyoming. Synonymized by Hood (1927b).

FEMALE (macropterous).—Length distended about 2 mm. Color dark brown except apex of each of the fore tibiae, fore tarsi, and basal half of antennal segment III which are yellowish brown. Body with red subintegumental pigment.

Head slightly longer than broad, anterior area bearing fore ocellus not particularly prolonged, surface of head with weak transverse striae. Eyes moderate in size, not prolonged ventrally more than dorsally. Ocelli present. Postocular setae minute, usually not much larger than the diameter of an ocellus, pointed. Antennal segment III with one inner and one outer sense cone; segment IV with two outer and two inner sense cones; segment VII with pedicel almost as narrow as in segment VI; segment VIII nonpedicellate, broadly joined to segment VII. Mouth cone relatively short, broadly rounded. Maxillary stylets placed fairly far apart within head, maxillary bridge broad.

Pronotum with most major setae developed although relatively short, pointed; anteromarginal setae minute. Praepectus present. Metanotum so weakly sculptured as to appear nearly smooth. Fore tarsi each armed with a small tooth. Fore wings slightly constricted in the middle; setae on basal vein spur nearly equal in size, small, pointed; each with six to eight accessory fringe cilia.

Pelta narrowly triangular with several pronounced longitudinal striae. Abdominal tergite IX with major posterior setae relatively short, pointed. Abdominal segment IX with internal rod (fustis) short. Tube moderate in size.

MALE.—Not known to be in Illinois and possibly not in North America.

Haplothrips leucanthemi is undoubtedly a Palearctic species which may have been introduced to North America and parts of the Orient and Australia in colonial times. It is either a composite of species or, as interpreted here, a single species with variable populations and individuals. Several names are available for all these variants or entities, as the case may be, and thysanopterists differ on the taxonomy involved. Some European stu-

dents believe that three or more species should be segregated; some North American students believe that at least the name *niger* should be suppressed, others that only *niger* should be used. Until the status of the species or several species is better understood. I prefer to lump all the specimens I have seen from this continent under the name *leucanthemi*, the type slide of which is apparently lost.

This species can be distinguished from all others in Illinois by the combination of the minute postocular setae, the narrow pedicel of antennal segment VII, and the presence of an inner sense cone on antennal segment III.

Haplothrips leucanthemi occurs commonly in the northern half of the state in flowers of daisy, yarrow, and possibly red clover. These host plants are also introduced from the Palearctic region. An excellent account of the life history of this thrips was given by Loan (1955) under the name of *Haplothrips niger*. Seemingly Pergande (1882) thought it may be predacious.

Illinois records.—Collected from spring to autumn, from one to several localities in the following counties: COOK, DU PAGE, LAKE, LIVINGSTON, McHENRY, OGLE, PIKE, STEPHENSON, and WILL.

Haplothrips (Karnyothrips) longiceps (Hood)

Zygothrips longiceps Hood (1908c:364).

♀. Type-locality.—Carbondale, Illinois.

FEMALE (brachypterous).—Length distended about 1.8 mm. Color dark brown except antennal segment III, which is yellow in pedicel and yellowish brown to yellow in apical half (inner margin and area just above pedicel sometimes light brown), and all tibiae and tarsi which are bright yellow. Body with red subintegumental pigment.

Head much longer than wide, nearly smooth. Eyes moderate in size. Ocelli small, fore ocellus smallest. Postocular setae moderate in size, dilated. Antennal segment III with one outer and no inner sense cone; segment VIII non-

pedicellate, broadly attached to segment VII. Mouth cone relatively short, broadly rounded. Maxillary stylets placed far apart within head, maxillary bridge broad.

Prothorax with major setae well developed and dilated except anteromarginal setae which are minute, posterior setae slightly longer than anterolateral and lateral setae. Praepectus present. Metanotum smooth. Fore tarsi each armed with a small tooth. Wings reduced to minute, nearly colorless pads.

Pelta roughly triangular, pores placed far apart. Abdominal tergite II nearly smooth. Abdominal tergites with most lateral and sublateral setae dilated. Wing-holding setae at most only slightly developed. Abdominal tergite IX with major posterior setae long, middle pair shorter and dilated, lateral setae pointed. Fustis short. Tube moderately small, with moderately long terminal setae.

FEMALE (macropterous).—Unknown.

MALE.—Unknown.

This species has been and is the subject of controversy. Hood (1949) stated that the name *errans*, western entity, is synonymous with *longiceps*. Cott (1956) and others suspect that *longiceps* and/or *errans* may be but the brachypterous form of *flavipes*. It is my opinion that *longiceps* is distinct from *flavipes* (*longiceps* always has the tibiae clear yellow whereas *flavipes* has the tibiae yellowish brown), and that *errans* is the brachypterous form of *flavipes*. As so defined *flavipes* is a cosmopolitan tramp of unknown origin, occurring from California to the gulf coast of Florida and other warm parts of the world—Hawaii, Egypt, India, the East Indies, etc. By contrast *longiceps* is a native species whose distribution apparently does not extend outside North America and which is rare west of Iowa.

Of the 150 or more specimens I have seen from Illinois, none are males and none are macropterous. Apparently *longiceps* is common throughout Illinois in native prairie grasses, especially *Andropogon*.

Illinois records.—Found every

month of the year, in one to several localities in the following counties: ADAMS, ALEXANDER, CHAMPAIGN, CLARK, COOK, CRAWFORD, DE WITT, DOUGLAS, HANCOCK, IROQUOIS, JACKSON, JERSEY, KNOX, LAKE, LAWRENCE, LEE, MADISON, MARION, MASON, MENARD, PIATT, PIKE, POPE, WAYNE, WHITE, WILL, and VERMILION.

Haplothrips (*Leptothrips*) *mali*
(Fitch)

The Black Hunter

Phloeothrips mali Fitch (1856:104). ? ♀. Type-locality.—State of New York. Transferred to *Haplothrips* by Stannard (1957b).

Cryptothrips aspersus Hinds (1902:205). ♀, ♂. Type-locality.—Amherst, Massachusetts. Synonymized by Hood (1914b).

Leptothrips aspersus macro-ocellatus Watson (1913:148). ? ♀. Type-locality.—Gainesville, Florida. Synonymized by Hood (1914b).

Cryptothrips adirondacks Watson (1921:83). ♀, ♂. Type-locality.—Cranberry Lake, New York. Synonymized by Hood (1927b).

Zygothrips floridensis Watson (1922b:22). ♂, see explanation herein. Type-locality.—Elpers, Florida. New synonymy.

FEMALE (macropterous).—Length distended about 2.5 mm. General color dark brown (in life blackish purple) except intermediate antennal segments. Segment III, basal half of segment IV, and pedicel of V yellow; sometimes all of segment IV, basal half of V, and pedicel of VI yellow. Wings colorless except for brown spot at base just above scale, apical fringe cilia of fore wings usually brown but occasionally white. Body with much purple subintegumental pigment.

Head (Fig. 228) elongate, much longer than wide, anterior area which bears fore ocellus considerably prolonged. Surface of head weakly marked with transverse striations. Eyes considerably more prolonged posteriorly on the ventral surface than on the dorsal surface of the head. Ocelli present. Postocular setae moderate in size,

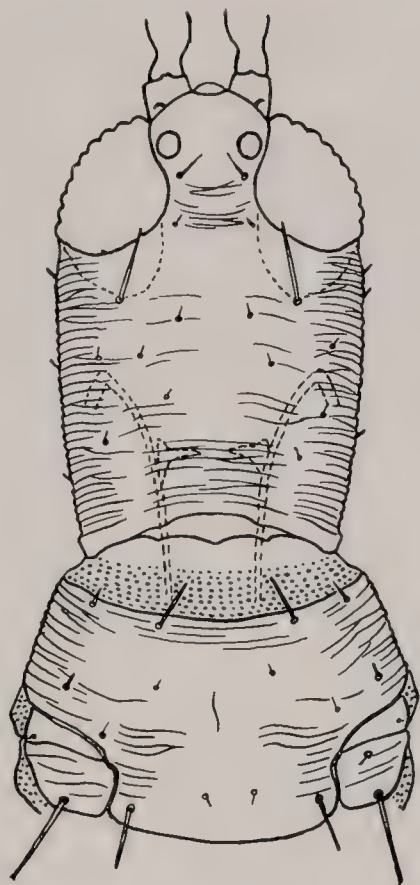


Fig. 228.—*Haplothrips* (*Leptothrips*) *mali*, head and prothorax.

blunt. Antennal segment III somewhat elongate, much longer than II, with no inner sense cone and one outer sense cone; segment IV elongate, with two outer and two inner sense cones; segment VIII nonpedicellate, broadly joined to segment VII. Mouth cone moderately long, nearly pointed. Maxillary stylets retracted about half way into head, placed fairly far apart within the head; maxillary bridge broad.

Prothorax (Fig. 228) generally transversely striate but with several smooth oval spots; with some major setae developed, anterolateral and lateral setae minute, posterior setae moderate in size, blunt. Praepectus present. Metanotum with distinct, closely spaced longitudinal striae. Fore tarsi unarmed. Fore wings slightly indented

in the middle, each with 3-10 accessory fringe cilia.

Pelta triangular (Fig. 170). Wing-holding setae well developed, sigmoidal. Abdominal tergites with lateral setae blunt. Abdominal tergite IX with major posterior setae long, pointed. Fustis short. Tube moderate in size.

MALE (macropterous).—Length distended about 2.2 mm. Similar to female in color and structure with the following exceptions. Eyes only slightly prolonged ventrally. Abdominal tergite IX with lateral posterior setae greatly reduced, spinelike. Abdominal sternite VIII without a differentiated glandular area.

This is the only species of the subgenus *Leptothrips* found in Illinois. It can be easily distinguished from all other *Haplothrips* by the strong longitudinal striae on the metanotum.

Two additional eastern species of *Leptothrips* are found in Florida. Both were described by Watson and both had been unjustly sunk under *mali* by Hood (1927b). One of these species, *pini*, differs from *mali* in having only two (not three or four) sense cones on antennal segment IV (O'Neill 1965), and the other species *cassiae*, has antennal segment III darker and shorter than in *mali*, nearly equal in length to segment V.

Two color forms of *mali* occur in our state. The light-colored form has the intermediate antennal segments predominantly yellow with antennal segment IV bearing only three sense cones and the apical fringe cilia of the fore wings appearing decidedly pale in color. By contrast the dark form, i.e., the normal color phase, has only antennal segment III entirely yellow, antennal segment IV bearing four sense cones, and the apical fringe cilia of the fore wings only slightly lighter brown than the adjacent cilia. Both forms often occur together, except in the Wisconsin drift area where only the dark form is present.

The single specimen of *Zygothrips floridensis*, labeled "Type" in the Watson collection, Gainesville, Florida, is a male, not a female as stated by Watson in his original description. In form and color it is like the dark form

of *mali* found in Illinois and may be considered an outright synonym of *mali*.

The type slide of *Leptothrips aspersus macro-ocellatus* was not present in the Watson collection when I studied it in 1961. Other slides available carried the label of this species but lacked data. These slides contain specimens similar to, if not the same as, *Leptothrips mali*, and accordingly I suspect this subspecies is also synonymous with *mali*.

Two slides of *Cryptothrips adironacks* are in the Watson collection, and although neither is marked holotype, one qualifies as such. To better fix this name, the lectotype is here designated to be the slide that bears a broken female and is labeled "Cranberry Lake, N. Y., July 5, 1920, on willow, C. J. Drake coll." The other slide labeled with the same locality but from *Viburnum alnifolium* contains a larva. These specimens have the characteristics of *mali*.

Other names have been sunk under *mali* in the past. Among these, *californicus* Daniel and *mconnelli* Crawford are not synonyms but, in my opinion, separate species.

It has been said frequently in the literature that *mali* is predacious, a habit shared by *Haplothrips subtilissimus* and others. From our numerous records, it appears that *mali* may occur in every woodland throughout the state.

Illinois records.—Found every month of the year, in one to several localities in the following counties: ADAMS, ALEXANDER, BOND, BROWN, BUREAU, CALHOUN, CARROLL, CHAMPAIGN, CLARK, CLAY, COLES, COOK, CRAWFORD, CUMBERLAND, DE WITT, EDGAR, EFFINGHAM, FAYETTE, FORD, FULTON, GALLATIN, GREENE, GRUNDY, HAMILTON, HANCOCK, HARDIN, HENDERSON, IROQUOIS, JACKSON, JASPER, JEFFERSON, JERSEY, JO DAVIESS, JOHNSON, KANE, KANKAKEE, KENDALL, KNOX, LAKE, LA SALLE, LAWRENCE, LIVINGSTON, LOGAN, MACON, MADISON, MARION, MARSHALL, MASON, MASSAC, MCLEAN, MERCER, MONROE, MORGAN, OGLE, PIATT, PIKE, POPE, PULASKI,

PUTNAM, RANDOLPH, RICHLAND, ROCK ISLAND, SANGAMON, SCHUYLER, SCOTT, STEPHENSON, TAZEWEEL, UNION, VERMILION, WASHINGTON, WILL, WILLIAMSON, WINNEBAGO, and WOODFORD.

**Haplothrips (Haplothrips)
malifloris Hood**

Haplothrips malifloris Hood (1916d: 121). ♀, ♂. Type-locality.—Roswell, New Mexico.

FEMALE (macropterous).—Length distended about 2.4 mm. General color dark brown. Antennal segment III with a slight yellowish tinge underlying the brown. Fore tarsi and apex of each of the fore tibiae yellowish brown. Wings clear except light brown at extreme base; fringe cilia brown with no white apical cilia. Body with orange-yellow subintegumental pigment.

Head distinctly longer than broad, anterior area which bears fore ocellus considerably prolonged. Surface of head weakly marked with transverse striations. Eyes not particularly prolonged ventrally more than dorsally. Ocelli present. Postocular setae moderate in size, pointed to blunt. Antennal segment III nearly equal to segment II in size, with no inner sense cone and one outer sense cone; segment IV with two inner and two outer sense cones; segment VIII broadly joined to segment VII. Mouth cone moderately long, pointed. Maxillary stylets retracted far into the head, placed fairly close together within the head; maxillary bridge short.

Prothorax with major setae developed but moderately small, anteromarginal and lateral setae smallest. Praepectus seemingly absent or greatly reduced. Metanotum with faint remnants of hexagonal reticulations. Fore tarsi each with a small inner median tooth. Fore wings slightly constricted in the middle, without accessory fringe cilia.

Pelta triangular, almost smooth. Wing-holding setae well developed, sigmoidal. Abdominal tergite IX with major posterior setae moderate in

size, shorter than tube, pointed. Abdominal segment IX with internal rod (fustis) greatly elongated. Tube relatively short.

MALE (macropterous).—Length distended over 1.8 mm. Similar in most respects to female with the following exceptions. Fore tarsal tooth usually slightly larger. Abdominal tergite IX with lateral posterior setae greatly reduced, spinelike. Abdominal sternite VIII apparently without glandular area. Only minor forms so far discovered in Illinois.

Haplothrips malifloris belongs to the *fasciculatus* complex, all females of which possess an extremely enlarged internal rod (fustis). This complex is transitional between *Haplothrips s. str.* and *Haplothrips* subgenus *Leptothrips*. Because they possess fore tarsal teeth, it seems advisable to include the species of this complex with the nominate subgenus.

The discovery of *malifloris* in Illinois came as a surprise. Heretofore, *malifloris* was considered to be a species of the southwestern states (Texas, New Mexico, and California). Its original collectors, Drs. M. W. Sanderson and T. E. Moore, found a large colony on *Froelichia campestris* growing on a dry railroad embankment in southwestern Illinois. Since then additional collections have been made from sand areas in Mason County. It might be that *malifloris* was transported to Illinois in recent times by the agency of man.

Illinois records.—JACKSON COUNTY: Murphysboro, August 25, 1953, Moore, Sanderson, on *Froelichia campestris*, 4 ♀, 3 ♂. MASON COUNTY: Mason State Forest, May 18, 1957, Kingsolver, Mockford, 1 ♀; Forest City, September 8, 1958, Ross, Stannard, sweeping herbs, 2 ♀.

**Haplothrips (Haplothrips)
shacklefordae Moulton**

Haplothrips shacklefordi Moulton (1927b:197). ♀, ♂. Type-locality.

Probably near Seymour, Champaign County, Illinois.

FEMALE (macropterous).—Length distended about 2.3 mm. General color

dark brown. Yellow: antennal segments III–VI (segment VII yellowish brown), apical half of fore tibiae, all tarsi, major setae of prothorax, and lateral setae of abdomen. Body with red subintegumental pigment. Wings colorless except for a light brown cloud in region of scale of fore wing.

Head (Fig. 229) longer than wide, anterior area not particularly prolonged, very weakly transversely striate. Eyes moderate in size, not prolonged ventrally more than dorsally. Ocelli present. Postocular setae small, pointed. Antennal segment III apparently without sense cones; segment IV with two outer and two inner sense cones; segment VII with a broad pedicel; segment VIII nonpedicellate, broadly joined to segment VII. Mouth cone relatively short, broadly rounded. Maxillary stylets placed far apart within head, forming a V; maxillary bridge broad.

Prothorax with anteromarginal and midlateral setae small to minute; major posterior setae moderate in size; all pointed. Praepectus present. Metanotum weakly sculptured so as to appear nearly smooth. Fore tarsi each armed with a short tooth. Fore wings slightly constricted in the middle; setae on basal vein spur subequal in size, small, pointed; each with about five accessory fringe cilia.

Pelta triangular with elongate hexagonal reticulations. Abdominal tergite IX with major posterior setae moderate in size, pointed. Abdominal segment IX with internal rod (fustis) short. Tube short.

MALE (macropterous).—Length distended about 1.7 mm. Similar in color and structure to female with the following exceptions. Abdominal tergite IX with major lateral posterior setae reduced in size. Abdominal sternite VIII apparently without any definite glandular area.

This species can be easily distinguished from its congeners in the Illinois fauna because it lacks sense cones on antennal segment III and has all tarsi yellow. It resembles *subtilissimus* in many ways but differs particularly in the absence of sense cones on antennal segment III and in having nondi-

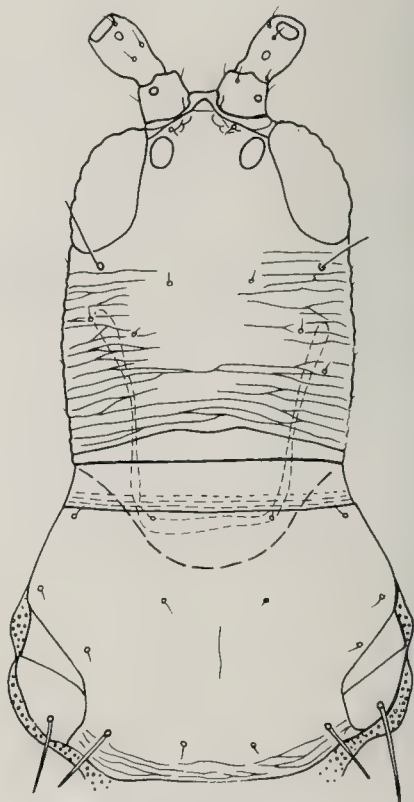


Fig. 229.—*Haplothrips* (*Haplothrips*) *shacklefordae*, head and prothorax.

lated body setae. From *fuliginosus* and the very similar, if not the same species, *nubilipennis*, *shacklefordae* differs by having the pores on the pelta closer together and lacking brown color in the fore wings near the mid constriction. The New York state species *xanthocrepis* also has the tarsi bright yellow but it differs from *shacklefordae* in having sense cones on antennal segment III and longer anterolateral and midlateral prothoracic setae.

Originally this species was collected by Miss Martha Shackleford, presumably in her study area of wet prairie near Seymour, Illinois. Properly, therefore, the patronym should have been spelled to end in *ae* as emended here. According to our observations, this insect is abundant on *Spartina* particularly in the northern and central parts of Illinois. It occurs westward into Iowa, Kansas, and Nebraska and eastward into Indiana

(INHS records). As yet its total distribution, which may include most of eastern United States, has not been determined.

Illinois records.—Collected in winter, spring, and summer, from one to several localities in the following counties: BOND, CHAMPAIGN, CHRISTIAN, CLINTON, DOUGLAS, DE WITT, DU PAGE, FULTON, HANCOCK, IROQUOIS, KANKAKEE, LIVINGSTON, MADISON, MARION, MARSHALL, MASON, MERCER, PIATT, ROCK ISLAND, SANGAMON, TAZEWEILL, and WHITESIDE.

Haplothrips (Haplothrips) subtilissimus Haliday

Phloeothrips subtilissimus Haliday (1852:1100). ? ♀. Type-locality.—England. Transferred to *Haplothrips* by Karny (1912b).

Haplothrips faurei Hood (1914b:157). ♀. Type-locality.—Ithaca, New York. New synonymy.

FEMALE (macropterous).—Length distended slightly over 2 mm. General color dark brown. Fore tibiae and all tarsi lighter brown to yellowish brown. Antennal segments I and II dark brown, segments III–VI yellow, segments VII and VIII light brown. Anterior body setae brown, posterior setae, except anal setae, yellow. Wings colorless except for light brown spot at base of each fore wing. Body with red subintegumental pigment.

Head slightly longer than wide, anterior area not particularly prolonged, weakly transversely striate. Eyes moderately large, not extended posteriorly on the ventral side as on the dorsal side. Ocelli present. Postocular setae moderate in size, slightly dilated. Antennal segment III with no inner and one outer sense cone; segment IV with two inner and two outer sense cones; segment VIII nonpedicellate, broadly joined to segment VII. Mouth cone short, broadly rounded. Maxillary stylets placed far apart within head; maxillary bridge broad.

Prothorax with anteromarginal setae minute; all major setae dilated. Praepectus present. Metanotum weakly sculptured, nearly smooth. Fore tarsi each armed with a short tooth.

Fore wings constricted in the middle, each with seven or eight accessory fringe cilia.

Pelta triangular, with weak longitudinally elongate reticulations. Abdominal segments II–VII with two pairs of sigmoidal wing-holding setae. Abdominal tergite IX with major posterior setae pointed at tips. Fustis moderate in size. Tube short.

MALE.—Unknown.

Although similar to *shacklefordae* in the color of the antennae and general form, *subtilissimus* can be distinguished by the characteristics of the darker tibiae, an outer sense cone on antennal segment III, and dilated postocular and prothoracic setae.

Long known as a predator on mites, *subtilissimus* is a holarctic species that in North America is generally confined to Canada and our most northern states. Its range barely extends down to Illinois. Priesner (1928) has listed the major synonyms of this species.

Illinois records.—JO DAVIESS COUNTY: East Dubuque, August 7, 1963, Smith, Braasch, Stannard, on willow, 5 ♀.

Haplothrips (Neoheegeria) verbasci (Osborn)

Mullein Thrips

Phloeothrips verbasci Osborn (1896:228). ♀, ♂. Type-locality.—Probably Iowa. Transferred to *Haplothrips* by Karny (1912b), and placed in *Neoheegeria* by Priesner (1920a). *Trichothrips femoralis* Moulton (1907:61). ♀, ♂. Type-locality.—Newcastle, California. Synonymized by Hood (1918).

FEMALE (macropterous).—Length distended about 2.4 mm. General color dark brown. Antennal segments III–VI abruptly yellow. Apical half of fore tibiae and all of fore tarsi yellow. Mid and hind tarsi yellowish brown. Wings colorless except for brown spot at base. Major head and prothoracic setae brown. Body with red subintegumental pigment.

Head slightly longer than wide, anterior area not particularly prolonged, dorsal surface weakly transversely

striate. Eyes moderate in size, not prolonged ventrally more than dorsally. Ocelli present. Postocular setae long, blunt. Antennal segment III with one inner and one outer sense cone; segment IV with two outer and two inner sense cones; segment VIII elongate, slender, nonpedicellate. Mouth cone moderate in size, pointed. Maxillary stylets placed moderately far apart, maxillary bridge moderately broad.

Prothorax with all major setae well developed and long, the posterior pairs being the longest, all blunt. Praepectus present. Metanotum weakly hexagonally sculptured. Fore tarsi each armed with a short subapical tooth. Fore wings constricted in the middle, each with about 10 accessory cilia.

Pelta triangular, pores just slightly farther apart than either is from the lateral margin. Wing-holding setae well developed, sigmoidal. Lateral setae mostly blunt. Abdominal tergite IX with major posterior setae moderately long, mid pair blunt, lateral pair pointed. Abdominal segment IX with fustis short. Tube moderately long.

MALE (macropterous).—Length distended nearly 2 mm. Similar to female except for the following. Fore tarsal tooth larger. Abdominal tergite IX with major lateral posterior setae reduced, spinelike. Abdominal sternite VIII apparently without any definite glandular area.

By the combination of the pointed mouth cone, the long head and prothoracic setae which are brown and blunt, and the abrupt yellow color of the intermediate antennal segments, this species may be easily distinguished from its congeners in Illinois.

Despite the fact that the type locality of *verbasci* is in North America, its provenience is probably Europe, whence it was introduced probably during the colonial times. It lives mostly between the leaves of European mullein and is common throughout Illinois. Bailey (1939c) has made observations on the life cycle of this thrips in California.

Illinois records (Fig. 18).—Collected every season of the year, from every county in the state.

Hindsiothrips Stannard

Boloplothrips Titschack (1957:409).

Nomen nudum, see explanation under discussion.

Hindsiothrips Stannard (1958a:273).

Type-species.—*Hindsiana pullata* Hood.

Head longer than wide, surface smooth except at extreme base. Eyes relatively small, as in *Haplothrips* subgenus *Karnyothrips*, never prolonged ventrally more than dorsally, not kegelike as in *Eurythrips*. Ocelli present in macropterous forms, absent in apterous forms. Postocular setae moderate in size to fairly long, pointed or dilated. Cheeks smooth without strong lateral setae. Antennae eight segmented; segment III nearly equal in length to segment IV, with at least one inner and one outer sense cone; segment IV with one inner and two outer sense cones; segment VIII decidedly lanceolate. Mouth cone short and broadly rounded. Maxillary stylets retracted far into the head, placed fairly close together within the center of the head. Maxillary bridge not discernible.

Thorax nearly smooth, without strong sculpture. Prothorax with anteromarginal setae short or long, anteroangular setae well developed; midlateral setae always short, posterior pairs of setae well developed; these setae pointed, blunt, or dilated. Epimeral sutures incomplete. Praepectus present. Mesopraesternum degenerate to nearly absent. Macropterous or apterous; fore wings, when present, of nearly even width throughout (not indented in the middle), without accessory fringe cilia near the apex of the trailing edge. Fore legs each armed with a small tooth.

Pelta nearly rectangular to trapezoidal, weakly sculptured. Wing-holding setae limited to one pair on each of abdominal tergites III–VII in the macropterous form, not differentiated in the apterous form. Abdominal tergite IX with major posterior setae longer than tube, always pointed; in males the lateral pair much reduced in size. Males apparently without a

distinct glandular area on abdominal sternite VIII. Females with a short internal rod (fustis) in abdominal segment IX. Tube relatively short; terminal setae not greatly elongate as is typical of *Haplothrips* subgenus *Karnyothrips*.

During my visit with Prof. Dr. Herman Priesner in 1960 at Linz, it was discovered that the name *Hindsiothrips* published in 1958 was synonymous with his yet unpublished *Boloplothrips*, to be based on *Trichothrips oettingeni* Priesner. Accordingly Priesner changed his manuscript name to *Hindsiothrips* and subsequently published articles using this latter name (Priesner 1960, 1961). Previously, however, he had advised Herr E. Titschack that the species *Watsoniella bonessi* Titschack was indeed a true "*Boloplothrips*," and thereupon Titschack in 1957, in a publication, re-assigned *bonessi* to *Boloplothrips* with the remark that this was a new genus being described by Priesner.

The International Code of Zoological Nomenclature (1961), Article 13, a, states: "a name published after 1930 must be either (i) accompanied by a statement that purports to give characters differentiating the taxon; or (ii) accompanied by a definite bibliographic reference to such a statement; . . ."

Titschack (1957) did not give direct diagnostic characteristics for the entity "*Boloplothrips*" and his bibliographic reference was to an unpublished manuscript. According to a strict interpretation of Article 13, a, "*Boloplothrips*" might be considered to be a *nomen nudum* as I have done here.

The first attempt to honor Dr. W. E. Hinds, an early and influential North American thysanopterist, by giving him a generic patronym (*Hindsiana*) failed because of synonymy. I hope that in this second attempt, the name *Hindsiothrips* is not also declared a synonym, merely because of the premature mention of a manuscript name.

Hindsiothrips can be recognized in Illinois by the incomplete epimeral sutures and the lanceolate form of antennal segment VIII. From *Eurythrips*,

a genus to which one species was originally assigned, the members of *Hindsiothrips* can be distinguished by the close spacing of the maxillary stylets within the head and by the nonbulged (not kegelike) eyes.

Two species, *pullatus* and *robustisetis*, occur in Illinois. Both are scarce in collections.

KEY TO SPECIES

1. Tarsi generally brown; postocular setae pointed. *pullatus*
- Tarsi generally yellow; postocular setae dilated. *robustisetis*

Hindsiothrips pullatus (Hood)

Hindsiana pullata Hood (1925b:27).

♀. Type-locality.—Macedon, New York. Transferred to *Hindsiothrips* by Stannard (1958a).

FEMALE (apterous).—Length distended nearly 1.5 mm. Almost entirely dark brown. Inner apical angles of femora and pedicel of antennal segment III yellow to colorless. Body with red subintegumental pigment.

Eyes relatively small. Ocelli absent. Postocular setae moderately long, pointed.

Prothorax smooth, with anteromarginal and midlateral setae short, anterolateral setae moderate in size, and posterior pairs somewhat longer; the smallest prothoracic setae blunt, the longer setae blunt to nearly dilated. Epimeral sutures incomplete. Fore tarsi each armed with a minute tooth.

Pelta nearly rectangular. Tube short.

FEMALE (macropterous).—Length distended about 1.6 mm. Similar to apterous female except for the following. Eyes slightly larger. Ocelli present. Wings fully developed, nearly uniformly light gray. Pelta in the form of an isosceles trapezoid. Wing-holding setae sigmoidal.

MALE (apterous).—Length distended about 1.5 mm. Similar to female in color and structure except for secondary sexual characteristics. Abdominal tergite IX with major lateral posterior setae reduced in size. Presence or absence of glandular area on abdominal sternite VIII not deter-

mined from single specimen available to me.

This species differs from *robustisetis* in color and by the form of the major head and prothoracic setae as mentioned in the key and the descriptions.

Although rare, in Illinois *pullatus* is probably statewide in distribution, occurring on dead branches. Besides those from Illinois, collections have been taken in New York and Arkansas (Stannard 1958a).

Illinois records.—HARDIN COUNTY: Karbers Ridge, May 4, 1950, Sanderson, Stannard, and August 17, 1951, Ross, Stannard, all on dead branches, 4 ♀. LAKE COUNTY: Wauconda, October 28, 1953, Ross, Stannard, bird's nest in tamarack bog, 1 ♂. MACON COUNTY: Decatur, Spitler Woods State Park, September 8, 1955, Stannard, dead branches, 1 ♀, 1 ♂. POPE COUNTY: Bell Smith Springs State Park, May 5, 1950, Sanderson, Stannard, beating oak leaves, 1 ♀.

Hindsiothrips robustisetis

(Watson and Preer)

Eurythrips robustisetis Watson and Preer (1939:3). ♀, ♂. Type-locality. —Swan Lake, Putnam County, Florida. Transferred to *Hindsiothrips* by Stannard (1958a).

FEMALE (apterous).—Length distended about 1.8 mm. General color yellowish brown. Antennal segments III–VIII, at least, median and lateral portions of the terminal abdominal segments, and tube brown. Anterior of head, pedicel of antennal segment III, inner apical angle of femora, apex of each of the tibiae, and all tarsi yellow. Body with red subintegumental pigment.

Eyes relatively small. Ocelli absent. Postocular setae moderate in size, dilated.

Prothorax with anterior and posterior setae all well developed, dilated; midlateral setae minute. Epimeral sutures incomplete.

Pelta rectangular. Tube short but slightly longer than in *pullatus*.

FEMALE (macropterous).—Unknown.

MALE (apterous).—Similar to fe-

male but smaller. Abdominal tergite IX with lateral major posterior setae slightly shorter than in female. No abdominal glandular area discernible.

This species differs from *pullatus* principally by the characteristics mentioned in the key. The holotype slide, deposited in the Watson collection, contains a female collected on June 22, 1936, by J. R. Watson from dead fallen oak and pine leaves, and has the name and the word "holotype" crossed off in pencil for no good reason known to me. I accept this slide as the authentic holotype.

It has been found infrequently over our state in ground litter of forest or prairies.

Illinois records.—CHAMPAIGN COUNTY: Seymour, February 28, 1936, Farrar, under ryegrass, 1 ♀. COOK COUNTY: east of Elgin, Shoe factory Road hill prairie, October 10, 1952, Ross, Stannard, *Andropogon*, 4 ♀; Palos Park, December 14, 1932, Frison, Ross, from soil cover, 2 ♀. HANCOCK COUNTY: Nauvoo, July 25, 1959, Evers, Stannard, forest debris, 2 ♀, 2 ♂. POPE COUNTY: Eddyville, Hayes Creek Canyon, October 23, 1959, Sanderson, forest debris, 3 ♀.

Hoplandrothrips Hood

Phloeothrips subgenus *Hoplandrothrips* Hood (1912c:145). Type-species by original designation.—*Phloeothrips* (*Hoplandrothrips*) *xanthopus* Hood (= *jenei* Hood). Raised to full generic rank by Hood (1915e).

Phloeobiothrips Hood (1925a:127). Type-species by original designation.—*Phloeobiothrips tumiceps* Hood. Synonymized by Stannard (1957b).

Head moderate in size and not particularly arched to elongate and considerably arched on dorsum, surface of head weakly reticulate. Eyes usually moderate in size, somewhat bean-shaped, occasionally shorter but often longer than the combined length of antennal segments I and II. Ocelli present in macropterous and brachypterous forms. Postocular setae usually well developed, usually dilated at tips; males with postocular setae longer

than in female. Basal pair of cheek setae often stouter than the rest. Antennae eight segmented, segment III often asymmetrical in profile with one inner and one or two outer slender sense cones, segment VIII pedicellate or nonpedicellate. Mouth cone pointed or more or less pointed. Maxillary stylets retracted far into the head, usually touching within the center of the head.

Prothorax at the most weakly sculptured, with most major setae well developed, usually dilated at tips. Males, especially major forms, with anterolateral prothoracic setae longer, and anteromarginal setae shorter, than in female. Epimeral sutures complete. Praepectal plates absent. Metanotum strongly sculptured either with hexagonal reticulations or longitudinal striations, sometimes weakly marked at base. Macropterous or brachypterous. Fore wings when present often slightly constricted in the middle and with a slight bulge on the surface at the middle, always with several accessory fringe cilia. Fore legs each usually with a tarsal tooth (absent in females and some males of those placed in the subgenus *Phloeobiothrips*) which is usually enlarged in the male, with two inner subapical fore femoral spurs and one inner subbasal fore tibial spur in most males and some females—these spurs and fore tarsal teeth greatly enlarged in many major males.

Pelta small, bellshaped to nearly triangular, often hexagonally reticulate. Wing-holding setae well developed, usually sigmoidal. Major posterior setae on abdominal tergite IX pointed, blunt, or dilated, lateral pair in males reduced and always pointed. Males usually with a weak, small, circular glandular area on abdominal sternite VIII, occasionally this glandular area broad and occupying much of sternite VIII. Tube moderate in size, sometimes somewhat elongate.

Larvae without head horns.

This genus is, at times, difficult to separate from a number of other genera. In Illinois *Hoplandrothrips* may be distinguished from *Acanthothrips* either by the lack of numerous large cheek warts or by having only one pair of prominent prothoracic epim-

eral setae, from *Hoplothrips* by always having the metanotum strongly sculptured, and from *Malacothrips* by not having bulged eyes.

In the Oriental and Australian regions, *Ecacanthothrips* resembles *Hoplandrothrips* and both are seemingly derived from a common ancestor if not one from the other. *Ecacanthothrips* differs mainly in having four or more sense cones on antennal segment III (instead of two or three as in *Hoplandrothrips*) and these sense cones are greatly thickened.

The eight species that occur in Illinois may be divided into two subgenera, *Hoplandrothrips* s. str. and *Phloeobiothrips*, on the basis of whether the female bears a fore tarsal tooth. At present I do not feel it is necessary to give these divisions subgeneric rank. However, for convenient reference to the older literature, I have mentioned the subgenera in the key and in the name of each species, following the system used in *Anaphothrips* in the preceding suborder.

Priesner (1923) presented a key to the then-known species of this group.

KEY TO SPECIES

(Males, which have not been satisfactorily analyzed, are included only in part.)

1. Antennal segment III with one outer sense cone.....2
- Antennal segment III with two outer sense cones.....3
2. Head greatly elongate; female without fore tarsal tooth.....*tumiceps*
- Head not as elongate; female with fore tarsal tooth.....*microps*
3. Metanotum with closely spaced longitudinal striations.....*juniperinus*
- Metanotal sculpture in the form of hexagonal reticulations; if reticulations elongate, sculpture never extremely closely spaced.....4
4. Females without fore tarsal tooth; head greatly elongate.....5
- Females with fore tarsal tooth; head only moderately long.....6
5. Tibiae brown.....*tumiceps*
- Tibiae yellow or yellowish brown.....*insolens*
6. Middle pair of major posterior setae on abdominal tergite IX pointed....*uzeli*
- Middle pair of major posterior setae on abdominal tergite IX dilated.....7
7. Tibiae yellow or yellowish brown; antennal segment III elongate.....*jennei*
- Tibiae largely brown; antennal segment III shorter.....*pergandei*

**Hoplandrothrips (Phloeobiothrips)
insolens Hood**

Phloeothrips (Hoplandrothrips) insolens
Hood (1912c:152). ♀. Type-
locality.—Dubois, Illinois.

FEMALE (macropterous).—Length distended over 2.6 mm. General color dark brown. Tibiae yellow to yellowish brown. Tarsi, basal two-thirds of antennal segment III, bases of antennal segments IV and V, and pedicel of antennal segment VI yellow. Fore wings pale yellow. Body with much red subintegumental pigment.

Head (Fig. 230) greatly elongate, considerably arched dorsally. Cheeks with four or five spines. Eyes relatively small. Postocular setae slightly longer than length of the eyes, dilated. Antennal segment III moderately elongate, with two outer sense cones; segment VIII with a broad pedicel.

Pronotal setae dilated. Metanotum hexagonally reticulate. Fore femora, tibiae, and tarsi unarmed.

Pelta bellshaped. Major posterior setae on abdominal tergite IX slightly

dilated to blunt. Tube moderately long.

MALE (macropterous).—Length distended, minor forms about 1.9 mm, major forms about 2.2 mm. Similar to female in general color and structure except for the following. Both forms with a small tooth on each of the fore tarsi, postocular and anterolateral setae longer, anteromarginal prothoracic setae shorter, and the lateral pair of the major posterior setae on abdominal tergite IX reduced and pointed. Major forms only with two pairs of subapical spurs on the inner surface of each of the fore femora and with a slight subbasal bump on the inner surface of each of the fore tibiae. Glandular area, if present on abdominal sternite VIII, not discernible in specimens I have seen.

This species is closely related to *tumiceps*. *Hoplandrothrips insolens* has the tibiae and tarsi yellow to yellowish brown, has more yellow color in antennal segment III, is macropterous, and has a longer metanotum, whereas *tumiceps* has the tibiae and tarsi brown, has more brown color in antennal segment III, is brachypterous as far as is known, and has a shorter metanotum. The shape of the pelta can also be used to distinguish these species.

Possibly *insolens* occurs throughout the state although the only northern records are from the Chicago region. It has been collected primarily from dead branches.

Illinois records.—CHAMPAIGN COUNTY: Homer (Hood 1925). COOK COUNTY: Orland Park, May 12, 1950, Stannard, dead willow and cottonwood, 1 ♀, 10 larvae. FULTON COUNTY: Anderson Lake Recreation Area, September 8, 1954, Ross, Stannard, dead willow, 1 ♀. JEFFERSON COUNTY: Mt. Vernon, May 9, 1951, Sanderson, Stannard, dead oak branches, 1 ♀, 1 ♂. LAWRENCE COUNTY: West Port, September 15, 1949, Ross, Stannard, willow branches, 1 ♀. MARSHALL COUNTY: Lacon, March 26, 1949, Evers, Stannard, under soft maple bark, 2 ♀. MASON COUNTY: Havana, November 9, 1943, Ross, Sanderson, ground cover, 1 ♂. PERRY

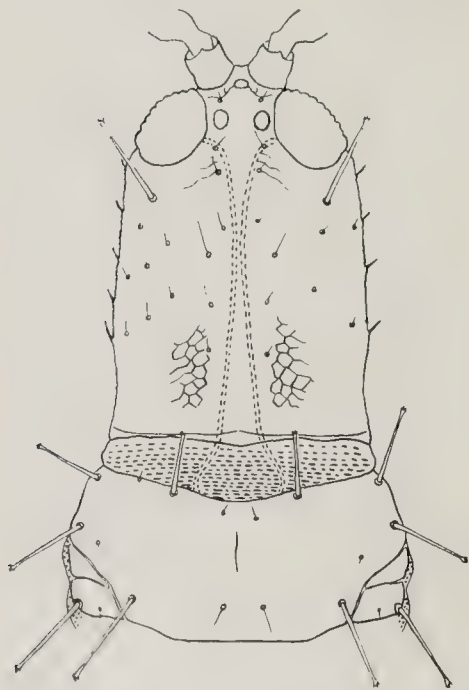


Fig. 230. *Hoplandrothrips (Phloeobiothrips) insolens*, head and prothorax.

COUNTY: Pyatts, October 28, 1964, Stannard, forest litter, 1 ♀. WASHINGTON COUNTY: Dubois (Hood 1912).

Hoplandrothrips (Hoplandrothrips) jennei (Jones)

Phloeothrips jennei Jones, P. R. (1912: 21). ♀. Type-locality.—Barnesville, Georgia. Transferred to *Hoplandrothrips* by Priesner (1923).

Phloeothrips (*Hoplandrothrips*) *xanthopus* Hood (1912c:145). ♀. Type-locality.—Pulaski, Illinois. New synonymy.

Phloeothrips floridensis Watson (1913: 147). ♀, ♂. Type-locality.—Gainesville, Florida. Synonymized by Hood (1927b).

Hoplandrothrips lateralis Stannard (1963b:137). ♀. Type-locality.—Seymour, Illinois. New synonymy.

FEMALE (macropterous).—Length distended about 2.5 mm. General color dark brown. Tibiae and median streak on abdominal tergites II–VIII yellowish to brown. Tibiae often in part yellow. Tarsi yellow. Antennal segment III except apical third, and segments IV–VII basally, yellow. Fore wings pale yellow. Body with much red subintegumental pigment.

Head (Fig. 231) moderately long. Cheeks with several spines, usually the basal pair being slightly thicker than the others. Postocular setae long, dilated. Antennal segment III elongate, with two outer sense cones; segment VIII broadly attached to segment VII, with a slight indication of a pedicel.

Major prothoracic setae dilated. Metanotum with hexagonal reticulations. Fore femora and tibiae not armed. Fore tarsi each with a moderate-sized tooth.

Major posterior setae on abdominal tergite IX with mid pair dilated, lateral pair long, pointed.

MALE (macropterous).—Length of major form distended about 2.5 mm, minor forms about 1.7 mm. General color and structure as in female with the following exceptions. Postocular and anterolateral prothoracic setae relatively long, anteromarginal prothoracic setae short. Major forms

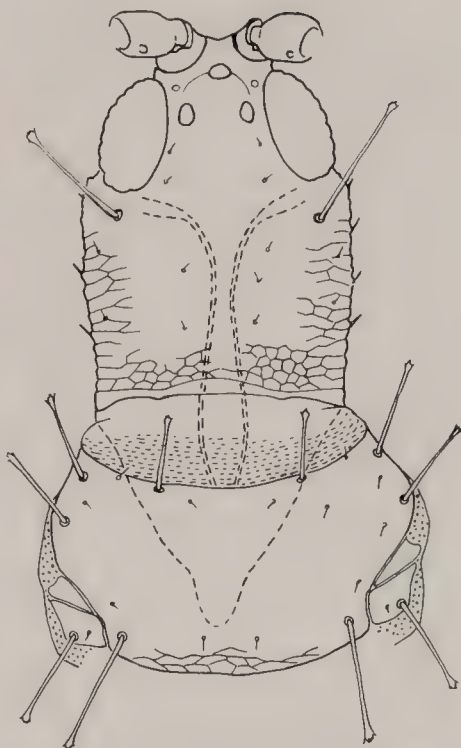


Fig. 231.—*Hoplandrothrips* (*Hoplandrothrips*) *jennei*, head and prothorax.

with fore legs enlarged, fore femora with two subapical spurs on inner surface, fore tibiae with a subbasal spur on inner surface, fore tarsi each with a greatly enlarged tooth. Minor forms with fore legs unarmed similar to female. Abdominal sternite VIII with a circular glandular area. Abdominal tergite IX with lateral setae reduced in size.

From *scutellaris* of New York state, *jennei* differs in not having all the major posterior setae of abdominal tergite IX decidedly dilated.

Phloeothrips floridensis Watson was sunk under *jennei* by Hood (1927b). Although the types are missing from the Watson collection and verification of this supposed synonymy is not possible, it seems expedient to accept Hood's decision.

My species *lateralis* was described before it was possible to see the Jones type which was kept in the then-forbidden Hood collection and before additional specimens were available.

I had separated *lateralis* from *xanthopus* on the basis of differences in the female sex, including the slightly longer head of *lateralis* and the fact that the major lateral posterior setae on abdominal tergite IX are pointed, not blunt, as in specimens of *xanthopus* in the collections of the Illinois Natural History Survey. After studies of more specimens it appears that the condition of these setae grade from pointed to blunt, and that even the leg color varies somewhat. As I later learned, Hood had his collection arranged to indicate that he also thought *xanthopus* was similar to, if not the same as, *jennei*.

In specimens of *jennei* from Texas, collected by Hood, the postocular setae are slightly shorter than in specimens from Illinois.

Illinois records.—Found every season of the year from grass, herbs, or branches, from one to several localities in the following counties: CHAMPAIGN, CLARK, CLINTON, COOK, DOUGLAS, EDGAR, HARDIN, IROQUOIS, JACKSON, KANE, MASON, MASSAC, MONROE, OGLE, PIATT, POPE, PULASKI, SANGAMON, and VERMILION.

Hoplandrothrips (Hoplandrothrips) juniperinus Hood

Phloeothrips (Hoplandrothrips) juniperinus Hood (1912c:146). ♀, ♂. Type-locality.—Plummer's Island, Maryland.

Hoplandrothrips proximus Hood (1927c:230). ♀, ♂. Type-locality.—Macedon, New York. New synonymy.

FEMALE (macropterous).—Length distended about 2.8 mm. General color dark brown. Antennal segment III except apex, basal third of segment IV, and pedicel of segment V yellow. Fore wings colorless. Body with much red subintegumental pigment.

Head moderate in size. Cheeks roughened by presence of many small wartlike tubercules. Basal cheek spines not particularly larger than the others. Postocular setae slightly shorter than length of eyes, dilated. Eyes moderate in size. Antennal segment III elongated with two outer sense cones; seg-

ment VIII with a short, very broad pedicel.

Major prothoracic setae dilated. Metanotum with closely spaced longitudinal striations. Fore femora and tibiae unarmed. Fore tarsi each with a moderate-sized tooth.

Major posterior setae on abdominal tergite IX dilated. Tube moderately long.

MALE (macropterous).—Length distended about 2.4 mm. Similar to female in general color and structure with the following exceptions. Postocular and anterolateral prothoracic setae longer, anteromarginal setae somewhat shorter. Fore femora with two small subapical spurs on inner surface, fore tibiae each with a small subbasal spur, fore tarsal teeth larger. Abdominal tergite IX with major lateral setae reduced, pointed. Glandular area, if present, not discernible on abdominal sternite VIII. All males known to me intermediate between minor and major forms.

This species may be recognized by the nearly uniform dark color, elongated third antennal segment, and closely spaced longitudinal striations on the metanotum.

So far *juniperinus* has been found only in the northern half of Illinois. It occurs on dead branches, including those of eastern red cedar (*Juniperus*).

Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 6, 1952, Richards, Stannard, on red cedar, 1 ♀, 4 larvae. CARROLL COUNTY: Palisades State Park, August 7, 1959, Stannard, dead branches, 2 ♂. CLARK COUNTY: Clarksville (Rocky Branch), September 14, 1949, Ross, Stannard, dead branches, 1 ♀. COOK COUNTY: Che-Che-Pinqua Woods, September 8, 1949, Ross, Stannard, dead twigs, 1 ♀, 2 larvae; Western Springs, June 16, 1949, Ross, Stannard, dead willow twigs, 3 ♀, 4 ♂. EDGAR COUNTY: Paris (Foley's Woods), June 14, 1950, Sanderson, Stannard, dead branches, 1 ♀, 1 ♂. JO DAVIESS COUNTY: Apple River Canyon State Park, August 25, 1949, Smith, Stannard, red cedar, 2 ♀, 2 larvae; May 10, 1955, Evers, Stannard, dead branches, 1 ♀. JOHNSON

COUNTY: Fern Cliff State Park, August 27, 1952, Ross, Stannard, dead branch, 1 ♀.

Hoplandrothrips (Hoplandrothrips) microps Hood

Phlaeothrips (Hoplandrothrips) microps Hood (1912c:150). ♀, ♂. Type-locality.—Marion, Illinois.

FEMALE (macropterous).—Length distended about 2.6 mm. Color dark brown except base of antennal segment III and pedicels of segments IV and V which are yellow to yellowish brown.

Head (Fig. 232) moderately elongate, slightly arched dorsally. Cheeks with four to six spines, the basal one just slightly larger than the rest. Eyes small, shorter than the combined length of antennal segments I and II. Postocular setae nearly equal to length of the eyes, dilated. Antennal segment

III elongate, with one outer sense cone; segment VIII broadly attached to segment VII and without a pedicel.

Major pronotal setae dilated. Metanotum with hexagonal reticulations. Fore femora and tibiae not armed. Fore tarsi each with a moderate-sized tooth.

Pelta triangular. Major posterior setae on abdominal tergite IX with mid pair dilated and lateral pair pointed.

FEMALE (brachypterous).—Similar to macropterous female except wings reduced to pads.

MALE (brachypterous).—Length distended, minor forms 1.6 mm, major forms nearly 2 mm. Similar to female with the following exceptions. Postocular setae much longer, anterolateral prothoracic setae longer, anteromarginal prothoracic setae slightly shorter. Tibiae and tarsi yellowish brown to yellow, fore femora with two subapical spurs on inner surface, fore tibiae with a subbasal and subapical spur, fore tarsal tooth longer. Major forms with spurs on fore legs larger than in minor forms. Abdominal sternite VIII with glandular area, if present, not discernible in specimens I have seen. Major posterior setae on abdominal tergite IX pointed, lateral pair reduced.

This is the only species of the genus in Illinois which has but one outer sense cone on antennal segment III and in which the female bears a fore tarsal tooth. It bridges the gap nicely between those which have the head moderate in size and a slight dorsal arch, as for example *jennei*, and those such as *insolens* which have the head greatly elongated and considerably arched.

Hoplandrothrips microps has been taken throughout the state on dead branches and under bark.

Illinois records.—Collected from middle spring to middle autumn from one to several localities in the following counties: ADAMS, COOK (Hood 1912c), CRAWFORD, JACKSON, JOHNSON, MARION, MASSAC, MORGAN, PIKE, POPE, PULASKI, RANDOLPH, WASHINGTON (Hood 1912c), WILLIAMSON (Hood 1912c), and WINNEBAGO (Hood 1912c).

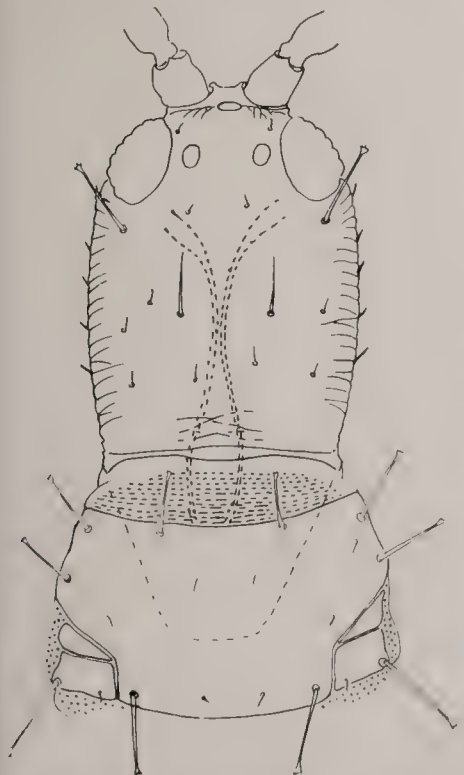


Fig. 232.—*Hoplandrothrips (Hoplandrothrips) microps*, head and prothorax.

**Hoplandrothrips (Hoplandrothrips)
pergandei (Hinds)**

Phloeothrips pergandei Hinds (1902: 197). ♀. Type-locality.—Amherst, Massachusetts. Transferred to *Hoplandrothrips* and redescribed by Hood (1942).

Phloeothrips (Hoplandrothrips) funebris Hood (1912c:148). ♀, ♂. Type-locality.—Carbondale, Illinois. New synonymy.

FEMALE (macropterous).—Length distended about 2.3 mm. General color dark brown. Tarsi and tip of each of the tibiae yellowish brown. Antennae varying from nearly entirely brown to brown with bases of segments III–VI yellow, sometimes margins of segment III and even IV yellow. Fore wings colorless. Body with much red subintegumental pigment.

Head (Fig. 233) moderate in size. Cheeks with a pair of strong basal spines. Eyes moderate in size. Post-

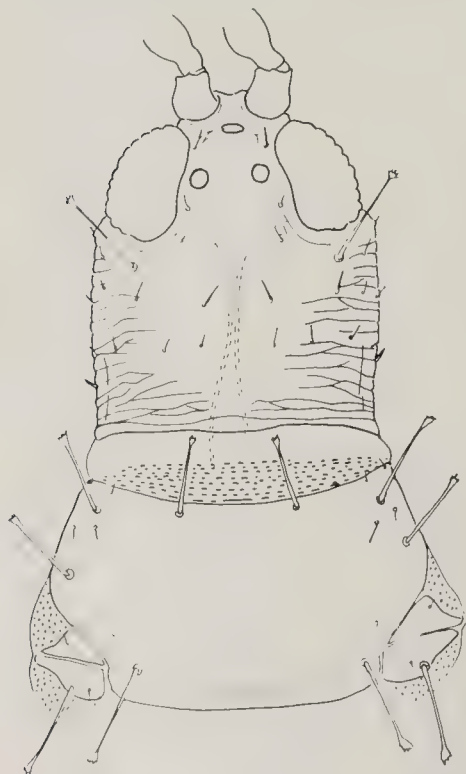


Fig. 233. *Hoplandrothrips (Hoplandrothrips) pergandei*, head and prothorax.

ocular setae dilated, nearly equal to the length of the eyes. Antennal segment III relatively short with two outer sense cones, segment VIII broadly attached to segment VII and without a pedicel.

Major pronotal setae dilated. Metanotum with hexagonal reticulations elongate but not to the point of becoming longitudinally striate as in *juniperinus*. Fore femora and tibiae not armed. Fore tarsi each with a small tooth.

Pelta as in Fig. 234. Major posterior setae on abdominal tergite IX dilated at tip. Major tube setae long.

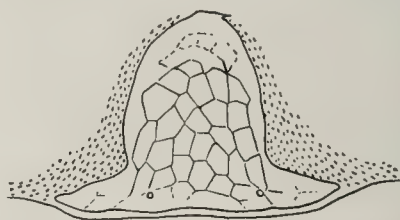


Fig. 234.—*Hoplandrothrips (Hoplandrothrips) pergandei*, pelta.

MALE (macropterous).—Length distended about 2 mm. Minor form similar to female except with two small subapical spurs on the inner side of each of the femora, with anterolateral prothoracic setae enlarged, and with anteromarginal setae reduced. Major forms with fore legs slightly more enlarged, with subapical fore femoral spurs larger, with evidence of a small subbasal spur on the inner surface of the fore tibiae, and with larger fore tarsal teeth. Abdominal sternite VIII with a small circular glandular area. Abdominal tergite IX with lateral setae reduced in size and pointed.

This species may be distinguished by the dark color of the legs, the non-pedicellate antennal segment VIII, the compact form of antennal segment III, and the dilated form of the tips of all major setae on abdominal tergite VIII.

According to Hood (1912c), *funebris*, here considered a synonym, generally has antennal segment III brown. Certain populations have since been found, however, in which the

specimens consistently have much yellow in antennal segment III as well as in other segments. All degrees of gradation of color of antennal segment III have been noted in our collections and presumably all representatives are conspecific. The type of *pergandei* has the intermediate antennal segments yellow at the bases. It would seem, therefore, that Hinds described the northern, stockier phase with lighter antennae whereas Hood in naming *funnebris* described the southern, smaller phase with darker antennae.

Hoplandrothrips pergandei occurs throughout the state on dead branches.

Illinois records.—Collected from May to October, from one to several localities in the following counties: ADAMS, CALHOUN, CARROLL, CLARK, CLINTON, COLES, COOK, CRAWFORD, CUMBERLAND, EDGAR, HARDIN, JACKSON, JASPER, KANE, LAWRENCE, LEE, MASON, MONROE, PIATT (Hood 1912c), PIKE, POPE, PULASKI, RANDOLPH, SCHUYLER, UNION, and VERMILION.

Hoplandrothrips (Phloeobiothrips) tumiceps Hood

Phloeobiothrips tumiceps Hood (1925a: 127). ♀, ♂. Type-locality.—Macedon, New York.

FEMALE (brachypterous).—Length distended about 2.4 mm. Almost entirely dark brown. Tarsi lighter brown. Basal half of antennal segment III and pedicels of segments IV–VI yellow to yellowish brown. Body with much red subintegumental pigment.

Head greatly elongate, considerably arched dorsally. Cheeks with three to six spineferous tubercules. Eyes relatively small. Postocular setae longer than the length of the eyes, dilated. Antennal segment III moderately elongate, with one outer sense cone (Hood, 1925, reported two outer sense cones); segment VIII with a broad pedicel.

Pronotal setae dilated. Metanotum weakly hexagonally reticulate, shorter than in *insolens*. Fore femora, tibiae, and tarsi unarmed.

Pelta nearly triangular. Major pos-

terior setae on abdominal tergite IX blunt. Tube moderately long.

MALE (brachypterous).—Unknown to me. According to Hood (1925a), similar to female in color and structure; fore tarsi each either armed with a short, blunt tooth, or unarmed.

Points of difference between this species and the closely related *insolens* are mentioned in the discussion of *insolens* and in the key.

Apparently *tumiceps* is a northern species, whereas its biological equivalent, *insolens*, occurs in more southern areas. So far *Hoplandrothrips tumiceps* has been taken three times in Illinois. It is also known from New York (Hood 1925a) and from the Quetico Provincial Park in Ontario (INHS).

Illinois records.—LAKE COUNTY: Volo Bog, October 8, 1953, Evers, Stannard, dead poison sumac leaf, 1 ♀; Wauconda Bog, September 22, 1961, Stannard, dead branch, 1 ♀. LA SALLE COUNTY: Streator, August 26, 1949, Smith, Stannard, dead willow branch, 1 ♀.

Hoplandrothrips (Hoplandrothrips) uzeli (Hinds)

Phloeothrips uzeli Hinds (1902:196). ♀, ♂. Type-locality.—Amherst, Massachusetts. Transferred to *Hoplandrothrips* by Hood (1912c).

FEMALE (macropterous).—Length distended about 2.5 mm. General color brown, being darkest in head, thorax, and terminal segments of abdomen, becoming yellowish brown to nearly yellow in basal abdominal segments except for median anterior spots which are always brown. Antennae brown except basal half of segment III and pedicels of IV and V which are yellow. Tibiae and tarsi yellow. Wings colorless. Body with much red subintegumental pigment.

Head moderate in size. Cheeks with a prominent basal spine on each side. Eyes small, much shorter than the combined length of antennal segments I and II. Postocular setae long, dilated. Antennal segment III shorter than in *jennei*, with two outer sense cones; segment VIII with a slender pedicel.

Prothorax with most major setae long, dilated; anteromarginal setae small. Metanotum smooth basally, weakly hexagonally reticulate posteriorly. Fore femora and tibiae unarmed. Fore tarsi each with moderate-sized tooth. Major posterior setae on abdominal tergite IX pointed. Tube moderately long.

MALE (macropterous).—Length distended, major forms about 2.4 mm, minor forms about 1.8 mm. Similar to female in general color and structure. Minor forms with at most a pair of small inner apical teeth on each of the fore femora, and a slight wartlike tooth on the inner basal angle of each of the fore tibiae. Major forms tend to have the basal segments of the abdomen darker; head, prothorax, and fore legs enlarged; two prominent inner apical teeth on each of the fore femora; a prominent subbasal fore tibial tooth; and the major head and prothoracic setae elongated. Abdominal sternite VIII seemingly with a small, circular glandular area. Abdominal tergite IX in all males with the lateral posterior setae reduced.

By the characteristics of the small eyes, the well-defined narrow pedicel on antennal segment VIII, and the pointed major setae on abdominal tergite IX in the female, this species may be easily distinguished from others in the Illinois fauna.

So far specimens of *uzeli* have been found only once in our state. The species occurs in grasses, particularly *Andropogon*.

Illinois records.—WAYNE COUNTY: Fairfield, August 17, 1951, Ross, Stannard, sod of *Andropogon*, 6 ♀, 11 ♂, 16 immatures.

Hoplothrips Amyot and Serville

Phlaeothrips Haliday (1836:441).

Type-species designation by Blanchard (1845).—*Thrips ulmi* Fabricius. Considered valid by Stannard (1957b) misidentification notwithstanding. Suppression of this designation requested by Mound (1966) to the International Commission on Zoological Nomenclature.

Hoplothrips Amyot and Serville (1843: 640). Type-species by subsequent

designation by Karny (1912b).—*Thrips corticis* DeGeer. Synonymized by Stannard (1957b). Placement of this name on the Official List of Generic Names in Zoology requested by Mound (1966) to the International Commission on Zoological Nomenclature.

Trichothrips Uzel (1895:246). Type-species by subsequent designation by Hood (1915e).—*Phlaeothrips pedicularia* Haliday. Synonymized by Stannard (1957b).

Dolerothrips Bagnall (1910b:682). Type-species by original designation.—*Dolerothrips flavipes* Bagnall. Synonymized by Stannard (1957b).

Pygmaeothrips Karny (1920:40). Type-species by monotypy.—*Pygmaeothrips columniceps* Karny. Synonymized by Stannard (1957b).

Neoeurhynchothrips Watson (1924a: 77). Type-species by original designation.—*Neoeurhynchothrips cubensis* Watson. Synonymized by Stannard (1957b).

Polyporotheis Watson (1927a:61). Type-species by original designation.—*Polyporotheis longipilosus* Watson. Synonymized by Stannard (1957b).

Head as broad as long to longer than broad, sometimes slightly arched on dorsum. Surface of head smooth to weakly reticulate, rarely warty. Eyes small to moderate in size, usually not much longer than length of antennal segment I, sometimes reduced to a few dorsal facets. Ocelli present in macropterous forms; present, reduced, or absent in brachypterous forms; absent in apterous forms. Postocular setae well developed, dilated to pointed. Basal cheek setae usually stouter than the rest, especially in major forms. Antennae eight segmented; segment III longer than II, with one inner and one or two outer sense cones; segment IV with two to four apical sense cones; segment VIII pedicellate, often lanceolate, or without pedicel and closely joined to segment VII. Mouth cone broadly rounded (Fig. 197) to pointed (Fig. 196). Maxillary stylets slender, often sigmoidal and nearly touching within center of head (Fig. 176).

Prothorax smooth to weakly sculptured, with most major setae well developed, pointed or dilated. Anteromarginal setae often minute, anterolateral setae longer in major forms than in minor forms. Epimeral sutures complete. Praepectus usually absent, present in one species in Illinois (*flavicauda*). Metanotum never strongly sculptured. Macropterous, brachypterous, or apterous. Fore wings when present usually not constricted in the middle, always with accessory fringe cilia. Fore legs not enlarged in minor forms, greatly enlarged in major forms, with or without fore tarsal teeth, sometimes fore tibiae and femora armed in major males much in the manner of *Hoplandrothrips*.

Pelta normally small and roughly triangular, especially in winged forms, occasionally fairly large in apterous forms. Wing-holding setae present in macropterous forms but not always strongly developed, often absent in brachypterous forms, always absent in apterous forms. Lateral abdominal setae pointed or dilated. Major posterior setae on abdominal tergite IX usually pointed, lateral pair in males reduced and pointed. Males usually with glandular area on abdominal sternite VIII, circular to oval to transversely band-like. Tube short to moderately long.

This genus is difficult to characterize because of the presence of so many forms. Additional complications arise because the extremes of the genus nearly grade into species in other genera.

In general, species of *Hoplothrips* lack strong reticulations, especially metanotal reticulations, which immediately separates them from *Hoplandrothrips* and from many *Liothrips*; each lacks a definite maxillary bridge, which usually separates them from *Haplothrips*; and each has slender maxillary stylets, which separates them from *Polyphemothrips*. Other characteristics, mentioned in the key to the genera and in the descriptions which follow, distinguish these species from the remainder of the family when the Illinois fauna only is considered.

Eleven species have so far been found in our state. Several of these,

smithi, *fumiceps*, and *terminalis* are rare, but some, such as *pergandei* and *beachae*, are often abundant. In fact, *pergandei* is one of the most common thrips in the forest litter of the Carolinian and Austroriparian faunal zones of eastern North America.

KEY TO SPECIES

- 1. Antennal segment IV greatly enlarged, with many minute sense cones on ventral surface...macropterous ♀ *fieldsi*
Antennal segment IV not greatly enlarged and without numerous minute sense cones on ventral surface.....2
- 2. Antennal segment VIII closely joined to segment VII, without discernible pedicel.....3
Antennal segment VIII pedicellate or lanceolate, with a broad or narrow pedicel.....4
- 3. Antennal segments IV–VIII, usually, pedicels of IV and V, and apical three-fourths of tube dark brown....*fieldsi*
Antennal segments mostly yellow although last two segments yellowish brown to brown; tube yellowish brown to yellowish orange.....*anomocerus*
- 4. Maxillary stylets, when retracted, forming a V within head.....*smithi*
Maxillary stylets, when retracted, closely placed within center of head.....5
- 5. Fore femora each with two inner subapical teeth and fore tibiae each with one subbasal tooth.....
.....major males of *flavicauda*
Fore femora and tibiae unarmed.....6
- 6. Praepectus present... (in part) *flavicauda*
Praepectus absent.....7
- 7. Prothorax with anteromarginal setae well developed, as long or nearly as long as anterolateral setae (Fig. 237).....8
Prothorax with anteromarginal setae small to minute, much smaller than anterolateral setae (Fig. 245).....10
- 8. Abdomen with most lateral setae dilated; head usually proportionately very long.....*angusticeps*
Abdomen with most lateral setae pointed; head usually not as long.....9
- 9. Antennal segment IV with two inner and two outer sense cones.....*terminalis*
Antennal segment IV with one inner and two outer sense cones.....*americanus*
- 10. Tube predominantly orange-yellow...11
Tube predominantly brown.....12
- 11. Antennal segment VII with apical sense cone placed dorsally.....*pergandei*
Antennal segment VII with apical sense cone placed on lateral angle...*fumiceps*
- 12. Eyes set in from cheek margins; all tibiae and tarsi usually sharply contrastingly yellow.....*corticis*
Eyes not particularly set in from cheek margins; mid and hind tibiae brown...*beachae*

Hoplothrips americanus (Hood),
generic reassignment

Trichothrips americanus Hood (1908c: 366). ♀, ♂. Type-locality.—Not stated but holotype labeled Urbana, Illinois. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended about 1.8 mm. General color brown and yellow. Yellow: head, pedicel of antennal segment III, legs, and abdominal segments VIII–X, except tip of tube (X) which is gray. Yellowish brown: antennal segments I and II and most of pterothorax and abdominal tergite I. Brown: antennal segments III–VIII except pedicel of segment III, prothorax, and abdominal segments II–VII. Sometimes individuals darker, with head, most of abdomen except tube, and femora yellowish brown to brown. Body with much red subintegumental pigment.

Head about as long as wide to slightly longer than wide. Eyes small, varying from a few to about a dozen dorsal facets. Ocelli absent. Postocular setae long, pointed, blunt or dilated. Antennal segments III–VIII each with a sharply narrowed pedicel, segment III with one inner and two outer sense cones, segment IV with one inner and two outer sense cones, segment VIII decidedly lanceolate. Mouth cone moderately long, rounded to almost pointed.

Prothorax with major setae well developed; anteromarginal setae often longer than the anterolateral setae, these setae pointed, blunt or dilated. Fore legs enlarged, each fore tarsus armed with a small to minute tooth. Wings reduced to pads.

Pelta (Fig. 235) in the shape of a broad transverse oval. Abdominal tergites without differentiated wing-

holding setae. Most lateral setae on abdominal tergites pointed to slightly blunt. Abdominal tergite IX with major setae long and pointed. Tube moderate in size.

FEMALE (macropterous).—Length distended about 2.1 mm. Similar in color to most brachypterous females, or darker. Darker individuals with body and femora generally brown, antennal segments I and II brown to yellowish brown, remainder of antennae dark brown. Tibiae and tarsi yellow. Wings light brown.

Similar to brachypterous female in structure with the following exceptions. Eyes much larger. Ocelli present. Mouth cone shorter. Wings fully developed, fore wings without accessory fringe cilia. Pelta more nearly triangular. Abdominal tergites with sigmoidal wing-holding setae.

MALE (brachypterous).—Length distended about 1.7 mm. Similar in color to brachypterous female including darker phase. Similar in structure to brachypterous female except for the following. Fore tarsi each armed with a slightly larger tooth. Anteromarginal setae of prothorax slightly smaller than anterolateral setae. Abdominal sternite VIII (Fig. 60) with a narrow, transverse, median glandular area. Abdominal tergite IX with major lateral posterior setae reduced in size.

This species belongs to that group of *Hoplothrips* of fairly light color that have the anteromarginal setae of the prothorax well developed. From *angusticeps*, which it resembles, *americanus* may be distinguished by the pointed, not dilated lateral abdominal setae.

Hoplothrips americanus is common under bark of rotting logs and stumps and forest leaf litter throughout Illinois.

Illinois records.—Found every month of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, BOND, CALHOUN, CHAMPAIGN, COOK, CUMBERLAND, EFFINGHAM, JACKSON (Hood 1908c), JEFFERSON, JOHNSON, KANE, LA SALLE, MASON, MCLEAN, PERRY, PIATT, POPE, PUTNAM, RICHLAND, ST. CLAIR, VERMILION, and WOODFORD.



235.—*Hoplothrips americanus*, ♀ male, pelta.

Hoplothrips angusticeps (Hood),
generic reassignment

Trichothrips angusticeps Hood (1908c: 367). ♀, ♂. Type-locality.—Not given, but holotype labeled St. Joseph, Illinois. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (brachypterous) (Fig. 236).—Length distended about 1.7 mm. General color brownish yellow. Head, prothorax, basal margins of most abdominal tergites, and posterior margin

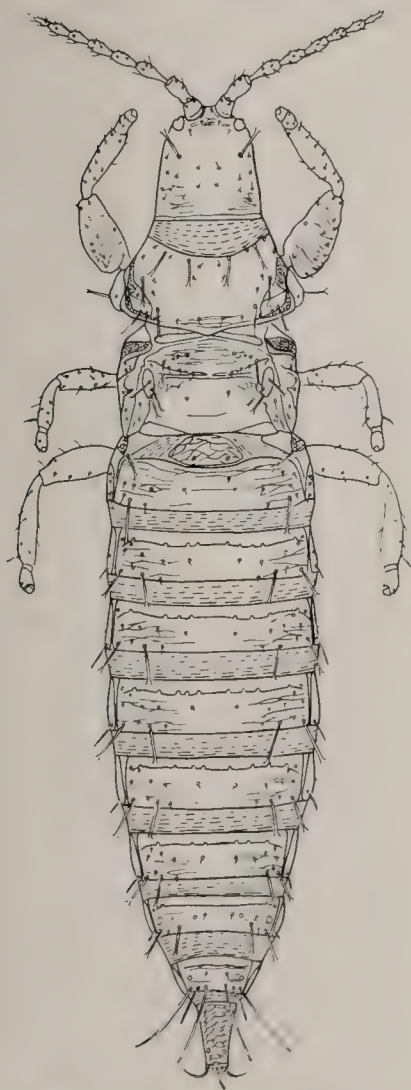


Fig. 236.—*Hoplothrips angusticeps*, dorsal aspect.

of abdominal tergite IX often brown; legs usually, and head sometimes, yellow. Tube usually yellow at base and tipped with gray. Antennal segments I, II, and base of III yellowish brown, remainder of antennae dark brown. Body with subintegumental pigment which appears dark gray by transmitted light.

Head (Fig. 237) usually much longer than wide and slightly arched. Eyes small with only a few dorsal facets. Ocelli absent. Postocular setae long, dilated. Antennal segments III–VIII each with a sharply narrowed pedicel, segment III with one inner and two outer sense cones, segment VIII decidedly lanceolate. Mouth cone (Fig. 196) moderately long, pointed.

Prothorax with major setae well developed, dilated; anteromarginal setae fully as long as anterolateral setae. Fore tarsi each with a small to minute tooth. Wings reduced to pads.

Pelta (Fig. 239) roughly triangular. Abdominal tergites without differentiated wing-holding setae. Most lateral setae on abdominal tergites usually greatly dilated (rarely blunt). Abdominal tergite IX with major posterior setae long and pointed. Tube short.

FEMALE (macropterous).—Length distended about 2.2 mm. Color brown except tibiae and tarsi which are yellow, head usually darkest. Wings light brown. Body with red subintegumental pigment.

Similar in structure to brachypterous female with the following exceptions. Eyes much larger, composed of many dorsal facets (Fig. 238). Ocelli present. Intermediate antennal segments usually more elongate. Wings fully developed, fore wings with accessory fringe cilia. Abdominal tergites with sigmoidal wing-holding setae.

MALE (brachypterous).—Length distended over 1.5 mm—minor forms slightly smaller than major forms. Similar to brachypterous female in color and structure with the following exceptions. Major forms tend to be slightly darker in color. Rudiment of fore ocellus present. Fore legs somewhat enlarged in minor forms, greatly enlarged in major forms. Fore tarsi

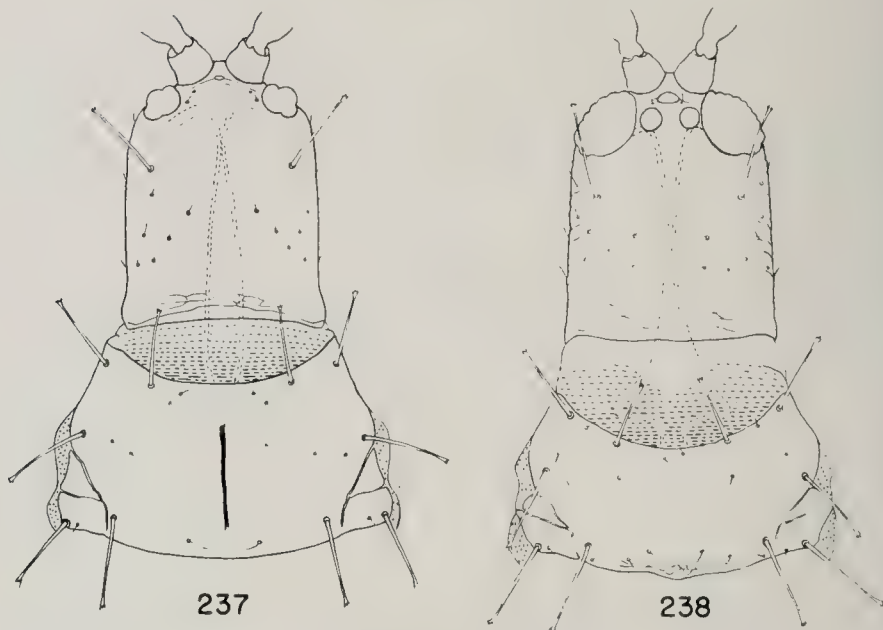


Fig. 237-238.—Head and prothorax; 237, *Hoplothrips angusticeps*, brachypterous; 238, *Hoplothrips angusticeps*, macropterous.

each with a large tooth. Anteromarginal setae of prothorax slightly smaller than anterolateral setae. Abdominal sternite VIII with a median elliptical glandular area. Abdominal tergite IX with major lateral posterior setae reduced in size.

This species is one of the group of moderately light-colored *Hoplothrips* which have the anteromarginal posterior setae about as long as the anterolateral setae. Its color, head size, and size of antennal segments are subject to some variation but the extent and distributions of these variants have not been analyzed yet in the populations. *Hoplothrips angusticeps* differs from its relative *americanus* in having most of the lateral setae of the abdomen dilated, usually in having a

longer head, and often in having a less contrasting, darker abdomen. According to the literature, the species *leibyi* (Hood) resembles *angusticeps* closely but I do not know *leibyi* and therefore, cannot differentiate the two at present.

Throughout Illinois this species is common under dead bark. Dr. R. C. Graves has taken specimens at Des Plaines, Illinois, from the fungus *Polyporus gilvus*. Apparently it (or very close relatives which have not yet been differentiated) ranges from Michigan to Costa Rica. Additional specimens from Micronesia in the collections of several American museums may also be members of this species as may *fereaceous* (formerly placed in *Pygmaeothrips*) from Sumatra.

Illinois records.—Found every month of the year, from one to several localities in the following counties: ADAMS, CHAMPAIGN, CLARK, COLES, COOK, FAYETTE, JACKSON, POPE, PULASKI, PUTNAM, RANDOLPH, RICHLAND, UNION, VERMILION, and WOODFORD.



Fig. 239. *Hoplothrips angusticeps*, pelta.

Hoplothrips anomocerus (Hood),
generic reassignment

Trichothrips anomocerus Hood (1912d: 137). ♀, ♂. Type-locality.—Plummer's Island, Maryland. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended about 2 mm. General color nearly entirely yellow to predominantly yellowish brown. Tips of antennae often yellowish brown to brown, tube usually yellowish yellowish brown to yellowish orange. Darker specimens with head, thorax, and anterior margin of abdominal tergites II–VIII yellowish brown to brown. Body with much purple subintegumental pigment.

Head moderate in size with cheeks straight. Eyes reduced to several dorsal and several ventral facets. Ocelli absent. Postocular setae moderately long and pointed. Antennal segment III with pedicel weakly striate, with one inner and one outer sense cone (occasionally or abnormally with two outer sense cones); segments VII and VIII compactly united. Maxillary stylets slender, retracted far into head and touching in the middle of the head. Mouth cone moderately long, rounded to almost pointed.

Pronotum with most major setae well developed, pointed; anteromarginal setae small. Mesospinasternum absent. Fore legs somewhat enlarged; fore tarsi each armed with a tooth. Fore wings reduced to tiny pads, hind wings apparently entirely absent.

Pelta roughly triangular. Abdominal tergites without differentiated wing-holding setae. Abdominal tergite II fractured into tiny platelets at sides. Abdominal tergite IX with major posterior setae moderately long and pointed. Tube short and stout.

FEMALE (macropterous).—Length distended over 2.2 mm. Similar in color to dark-colored brachypterous female. Similar in structure to brachypterous female with the following exceptions. Eyes much larger with many dorsal facets. Ocelli present and fully developed. Wings fully developed

but partially destroyed in the single specimen I have studied. Abdominal tergite II seemingly nearly complete at sides. Wing-holding setae sigmoidal.

MALE (brachypterous).—Length distended about 1.8 mm. Color generally yellow except antennal segments VII and VIII yellowish brown and tube yellowish orange. Similar to brachypterous female with the following exceptions. Fore tarsal teeth slightly enlarged. Prothorax larger. Abdominal tergite IX with lateral posterior setae shorter and thicker. Abdominal sternite VIII, near the posterior border, with a narrow transverse glandular area which is separated in the middle and divided into two parts.

This distinctive species was originally related to *Polyphemothrips ambitus* on the basis of the similarity of the compactly united terminal antennal segments. The two can be easily separated by the following features. *Polyphemothrips ambitus* has thicker maxillary stylets, a longer head, differently colored antennae, and has the tube tipped with black. The compact form of antennal segments VII and VIII and the lack of strong serrations on the pedicel of antennal segment III distinguish *anomocerus* from other species of *Hoplothrips* in Illinois.

In collections, *anomocerus* is scarce and little is known of its habits. Hood (1917) records specimens from the bark of sycamore and grape. Watson (1945) considers this species to be common in forest ground litter. We have taken it in scattered places throughout Illinois, mostly in forest litter.

Illinois records.—ALEXANDER COUNTY: Olive Branch, March 15, 1960, Stannard, forest debris, 1 ♀. BOND COUNTY: Greenville, October 26, 1956, Ross, Smith, Stannard, woodland debris, 2 ♀. CHAMPAIGN COUNTY: Urbana (Busey's Woods), October 12, 1955, Kingsolver, forest debris, 1 ♀. COOK COUNTY: Oakland, October 19, 1947, Stannard, ground cover, 2 ♀, 1 ♂. HAMILTON COUNTY: Broughton, May 2, 1956, Stannard, dead branch, 1 ♀. LAKE COUNTY:

Wauconda, March 16, 1933, Frison, Mohr, tamarack bog, 1 ♀. PERRY COUNTY: Pyatts, November 12, 1964, Stannard, forest debris, 5 ♀, 4 ♂. RICHLAND COUNTY: Olney, November 9, 1953, Smith, Stannard, forest debris, 1 ♀.

Hoplothrips beachae (Hinds),
emended spelling and generic
reassignment

Trichothrips beachi Hinds (1902:192).

♀. Type-locality.—Amherst, Massachusetts. Transferred to *Phlaeothrips* by Stannard (1957b).

Trichothrips karnyi Hood (1914d:20).

♀, ♂. Type-locality.—Plummer's Island, Maryland, stated by Hood (1917). New synonymy.

Trichothrips karnyi major Hood

(1914b:153). ♀. Type-locality.—Newton, Pennsylvania. Raised to full specific rank by Hood (1927b). New synonymy.

Trichothrips drakei Watson (1921:78).

♀. Type-locality.—Syracuse, New York. Synonymized under *Trichothrips major* by Hood (1927b).

FEMALE (macropterous).—Length distended from 2.2 mm (minor forms) to over 3.5 mm (major forms). General color dark brown. Yellow to yellowish brown: most of antennal segment III, bases of antennal segments IV–VI, bases and apexes of tibiae (occasionally fore tibiae entirely yellow), and all tarsi. Base and tip of tube light brown. Wings washed with pale yellowish brown. Body with red or purplish red subintegumental pigment.

Head nearly as wide as long (minor forms) to much longer than wide (major forms). Eyes moderately large, just slightly shorter than the combined lengths of antennal segments I and II. Ocelli present. Cheeks usually extended nearly evenly up to eyes, with two or three pairs of stout bristles which are particularly pronounced in major forms, sometimes small in minor forms. Postocular setae long, pointed. Antennal segment III with one inner and two outer sense cones, these cones relatively longer in minor forms, relatively shorter in major forms; antennal segment VIII with a short, broad ped-

icel. Mouth cones moderately long, rounded to almost pointed.

Pronotum with most major setae well developed; midmarginal setae minute, midlateral setae small in minor forms, moderate to long in major forms. Fore tarsi armed, tooth small in minor forms, large in major forms. Fore wings with accessory fringe cilia.

Pelta (Fig. 240) roughly triangular with basal angles sometimes extended slightly. Wing-holding setae well developed, sigmoidal. Abdominal tergite IX with major posterior setae moderately long and pointed. Tube moderately long.

FEMALE (brachypterous).—Length distended 2.5 mm (minor forms) to 4.5 mm (major forms). Similar in all respects to macropterous female except wings reduced to pads and eyes slightly smaller. Extreme minor forms not known to be present as is the case in the macropterous stage.

MALE (macropterous).—Length distended 2 mm (minor forms) to over 3 mm (major forms). Similar in most respects to macropterous female with the following exceptions. Major forms have fore legs greatly enlarged, and each fore tarsus bears a stouter tooth. Abdominal sternite VIII usually with a median transverse, bandlike glandular area, this area varying from moderately broad to narrow; in one case (possibly a freak) this glandular area reduced to an ellipse. Abdominal tergite IX with major lateral setae reduced in size, shortest in major forms, longest in minor forms.

MALE (brachypterous).—In size and structure similar to macropterous male except wings reduced to pads and eyes slightly smaller.

This is an extremely variable species, composed of major, minor, and intermediate forms, in which certain structures—i.e. head proportions, antennal sense cones, prothoracic antero-



Fig. 240.—*Hoplothrips beachae*, pelta.

lateral setae, and fore tarsal teeth—are proportionately longer or shorter according to form. In addition, the shape of the male glandular area varies from a narrow transverse band to a broad transverse band. Some thysanopterists believe that several of the variants or forms represent separate species, but if this is so, no characteristics have yet been discovered or proposed which would allow absolute separation of one from the others. Because the differences noted intergrade almost imperceptibly from one extreme to another, I prefer to regard these forms as one species. In fact, our North American representatives may be but racial segregates of a wide-ranging holarctic species which also occurs in Europe and Asia under other names, *Hoplothrips ulmi* and *funqi*, etc. Because it was named in honor of Miss Alice Beach, it should take the feminine *ae* ending.

From *corticis*, which it resembles, *beachae* may be distinguished by the form of the cheeks which are not particularly extended laterally from the eye margin.

Throughout Illinois, this species is common on dead branches and dead stumps. Often it lives in large aggregations with adults, larvae, and pupae closely massed together.

Illinois records.—Collected from late March to late November, in one to several localities in the following counties: ADAMS, CALHOUN, CHAMPAIGN, CLARK, COOK, EDGAR, EFFINGHAM, FULTON, HARDIN, HENRY, IROQUOIS, JACKSON, JOHNSON, KANE, KANKAKEE, LAKE, LA SALLE, LAWRENCE, MASON, MASSAC, McDONOUGH, MCHENRY, OGLE, PEORIA, PIKE, POPE, PULASKI, ROCK ISLAND, and WABASH.

Hoplothrips corticis (DeGeer), generic reassignment

Thrips corticis DeGeer (1773:11). ? ♀.

Type-locality.—Sweden. Transferred to *Phlaeothrips* by Morison (1949). Generic reassignment requested of the International Commission on Zoological Nomenclature (Mound 1966).

Trichothrips copiosa Uzel (1895:252). ♀, ♂. Type-locality.—Bohemia (Czechoslovakia) or Lapland. Synonymized by Hood (1915e).

FEMALE (brachypterous—specimens from Illinois).—Length distended 2.5–3 mm. General color yellowish brown to brown. Intermediate antennal segments somewhat lighter yellowish brown (in European and Pennsylvanian specimens segment III, sometimes segment IV, and bases of IV–VI definitely yellow). All tibiae and tarsi yellow, although outer mid portion of mid and hind tibiae sometimes clouded with light brown. Tube brown.

Head about as wide as long. Eyes smaller than length of antennal segments I and II combined. Ocelli present but slightly reduced in size. Postocular setae long, pointed. Cheeks more extended laterally from eyes than in *beachae*. Antennal segment III with one inner and two outer sense cones; segment VIII with a short, broad pedicel. Mouth cone moderately long, bluntly rounded to nearly pointed.

Prothorax with most major setae developed, pointed; anteromarginal setae minute; anterolateral setae small in minor forms, longer in major forms (Pennsylvanian specimens). Fore tarsi each armed with a well-developed tooth. Wings reduced to pads.

Pelta roughly triangular. Abdominal tergites with wing-holding setae developed but small. Abdominal tergite IX with major setae long and pointed. Tube moderately long.

FEMALE (macropterous—specimen from Denmark).—Length distended over 2.5 mm. Similar to brachypterous female in color and structure with the following exceptions. Eyes and ocelli slightly larger. Wings clouded with yellowish brown, fore wings with accessory fringe cilia. Abdominal tergites with wing-holding setae well developed.

MALE (brachypterous—specimens from Pennsylvania).—Length distended about 2.1 mm (minor forms) to 3 mm (major forms). Similar in color and structure to brachypterous

female with the following exceptions. Major forms with prothorax and legs greatly enlarged. Abdominal sternite VIII with a median transverse band-like glandular area. Abdominal tergite IX with major lateral posterior setae reduced in size.

MALE (macropterous).—Unknown to me.

In Illinois this species closely resembles *Hoplothrips beachae* in appearance and in habitat. Because *beachae* usually has the mid and hind tibiae largely brown and the eyes not particularly set in from the outer cheek margin, whereas *corticis* usually has all tibiae yellow and the eyes more set in from the outer cheek margin, the two species can be fairly readily distinguished.

Specimens I have seen from Illinois and North Carolina have darker colored antennae than specimens from Pennsylvania and Europe. A specimen that I collected from the wilderness area in the Quetico Provincial Park, Canada, can also be assigned to this species.

Whether this species is a native representative of a holarctic species or whether it is an immigrant to the New World as a stowaway with European man cannot be positively ascertained on the evidence available. At any rate, it has been known from Illinois since 1909 (Hood 1914b) and apparently it is established in Urbana, at least. It occurs under dead tree bark.

Illinois records.—CHAMPAIGN COUNTY: Urbana, 1909 (Hood 1914); Urbana (Trelease Woods), July 14, 1955, Webb, 2 ♀.

Hoplothrips fieldsi (Crawford, J. C.)

Hoplothrips (*Trichothrips*) *fieldsi* Crawford, J. C. (1939:77). ♀, ♂. Type-locality.—Olive Bridge, Ulster County, New York. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended about 2.5 mm. General color yellow with brown markings. Dark brown: apical two-thirds of antennal segments IV and V, all of antennal segments VI–VIII, and apical three-

fourths of tube except sometimes slightly lighter near apex. Light brown: prothorax and sides of pterothorax, coxae, and anterior pair of blotches on abdominal tergites II–VIII.

Head slightly indented just before eyes. Eyes reduced with only a few dorsal facets. Ocelli absent. Antennal segment III deeply scalloped in pedicel, with one inner and one outer sense cone; segment IV not enlarged, with few if any ventral minute sense cones; segments VII and VIII closely joined but not as compact as in *anomocerus*. Postocular setae well developed and pointed. Mouth cone fairly short, rounded to nearly pointed.

Pronotum with most major setae moderately long and pointed to blunt; anteromarginal setae minute. Mesopinasternum greatly reduced. Mesoscutum fractured into tiny platelets along anterior margin. Fore legs enlarged, fore tarsi each with a slender, sharp tooth. Fore wings reduced to extremely minute pads, hind wings entirely absent.

Pelta trapezoidal. Abdominal tergites without differentiated wing-holding setae. Abdominal tergite IX with major posterior setae short, pointed. Tube relatively short but not as stout as in *anomocerus*.

FEMALE (macropterous).—Length distended about 2.7 mm. Body generally brown. Antennal segments II and III, all tibiae and tarsi, and posterior and median portions of most of the abdominal tergites yellow. Antennal segments IV–VIII and most of tube dark brown.

Similar in structure to brachypterous female with the following exceptions. Eyes large with many dorsal facets. Ocelli present. Antennal segment IV greatly enlarged, segments IV and V with many minute sense cones on ventral surface. Mesopinasternum degenerate but not as reduced as in the brachypterous form. Wings fully developed, fore wings with accessory fringe cilia. Pelta more nearly triangular. Wing-holding setae sigmoidal.

MALE (brachypterous).—Length distended about 1.6 mm (minor

forms) and about 2.1 mm (major forms). Similar to brachypterous female in color and structure with the following exceptions. Major form with fore legs, fore tarsal tooth, and prothorax greatly enlarged. Abdominal sternite VIII with a broad transverse glandular area (Fig. 61), largest in the major form. Abdominal tergite IX with major lateral posterior setae reduced.

According to J. C. Crawford (1939) this species is closely related to the European species *semicaecus* Uzel because both have numerous minute sense cones on antennal segments IV and V. On the same basis *fieldsi* is also related to the European *amabilis* Bagnall. If *semicaecus* and *fieldsi* are different species, it may be that Hood's record (1914b) of *semicaecus* from Bennings, Washington, D. C. may prove to be *fieldsi* instead, and *semicaecus* should be stricken from the list of American species. Apparently in Illinois *fieldsi* is the only species which, in the macropterous form, has antennal segment IV enlarged and which has these minute sense cones on several antennal segments.

So far our collections of this species have been limited to the southern half of the state, under dead bark.

Illinois records.—CLINTON COUNTY: Carlyle, August 15, 1951, Ross, Stannard, dead branch, 1 ♂. HARDIN COUNTY: Karbers Ridge (High Knob), August 18, 1950, Stannard, dead plum, 2 ♀. LAWRENCE COUNTY: Westport, September 15, 1949, Ross, Stannard, willow branch, 1 ♀. PULASKI COUNTY: Mounds, August 16, 1951, Ross, Stannard, dead beech, 3 ♀, 1 ♂.

Hoplothrips flavicauda (Morgan), generic reassignment

Trichothrips flavicauda Morgan (1913: 28). ♀, ♂. Type-locality.—Corbin, Kentucky. Transferred to *Phlaeothrips* by Stannard (1957b).

Hoplothrips (*Trichothrips*) *myceticola* Crawford, J. C. (1939:75). Type-locality.—Cresskill, New Jersey. Synonymized by Hood (1954a).

FEMALE (apterous).—Length dis-

tended about 1.5 mm. General color brown. Head sometimes yellow in the entire median portion or in the median part of the dorsolateral margins, sometimes entirely brown. Antennal segments I and II, apical half of fore femora usually, fore tibiae, and fore tarsi yellow. Basal portions of intermediate antennal segments, legs at joints, and abdominal segment IX yellowish brown. Tube yellow, tipped with gray.

Head about as broad as long. Eyes small with about 10 dorsal facets, decidedly set in from lateral cheek margin. Ocelli absent. Postocular setae moderate in size, pointed. Antennal segments III and IV each with one inner and one outer sense cone, antennal segment VIII lanceolate. Mouth cone broadly rounded; maxillary stylets retracted far into head, nearly touching in the central portion of the head.

Prothorax with all major setae developed, moderate in size, blunt; anteromarginal setae small but not minute, at least three-fourths the size of anterolateral setae. Praepectus usually present. Pterothorax typical of extreme apterous condition and without trace of wing pads. Fore tibiae unarmed.

Pelta large, extending over more area of abdominal segment I than is typical for the genus. Wing-holding setae not developed. Abdominal tergite IX with major posterior setae moderate in size, pointed. Tube relatively short.

FEMALE (brachypterous or dealated macropterous).—Length distended about 1.5 mm. Similar to apterous female with the following exceptions. Sometimes darker and usually abdominal tergite IX brown. Eyes much larger, extended nearly to cheek margin. Ocelli present. Antennal segments III and IV each with two outer sense cones. Prothorax (Fig. 241) with anteromarginal setae reduced, minute. Pelta reduced in size, roughly triangular. Wing-holding setae on abdominal tergites only slightly more developed than in apterous form.

MALE (apterous).—Length distended about 1.2 mm (minor forms) to

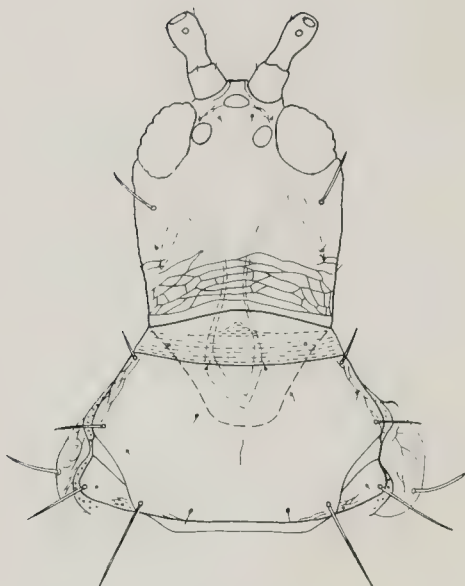


Fig. 241.—*Hoplothrips flavicauda*, ♀ macropterous, head and prothorax.

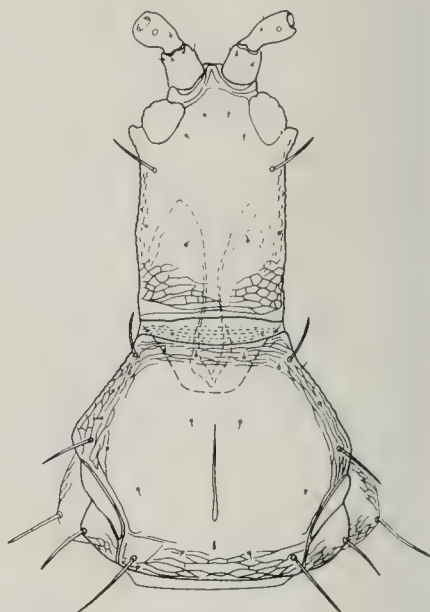


Fig. 242.—*Hoplothrips flavicauda*, ♂ major form, head and prothorax.

1.4 mm (major forms). Similar to apterous female with the following exceptions. Major forms, particularly extreme major forms, with head (Fig. 242) minutely warty, cheeks produced laterally just behind eyes, fore legs and prothorax greatly enlarged, a large tooth on each fore tarsus, fore femora bearing two subapical inner spurs, and fore tibiae bearing one subbasal inner spur much as in *Hoplandrothrips* or *Neurothrips*. Minor forms more robust than apterous female, but without fore femoral and fore tibial spurs, and cheeks not especially produced behind eyes. In all males the anteromarginal setae are minute and the posterior lateral setae of abdominal tergite IX are reduced. Seemingly no glandular area is present on abdominal sternite VIII.

MALE (macropterous, dealated).—Length distended over 1.5 mm. Similar to macropterous female with the following exceptions. Fore tarsi each with a large tooth. Abdominal tergite IX with posterior lateral setae reduced. Apparently no glandular area on abdominal sternite VIII.

This species and its close allies (*fungosus* of the Pacific islands for ex-

ample) are not typical of the genus because of the presence of praepectal plates. Between the apterous stage and the fully winged stage, and between the sexes, they exhibit great points of difference which include the presence or absence of teeth on the fore tarsi, the enlargement or reduction of the fore legs, cheek projections, shape of the pelta, and the presence of one or two outer sense cones on antennal segments III and IV.

In some respects *flavicauda* resembles *Lissothrips muscorum* but in *flavicauda* antennal segment III is not reduced in size and by this characteristic the two may be easily distinguished. From *smithi*, *flavicauda* may be recognized by the close placement of the maxillary stylets within the head, usually by the presence of praepectal plates, by the eyes which are set in from the cheek margins, and by the absence of teeth on the fore tibiae in the female sex.

Hoplothrips flavicauda is found throughout Illinois on dead branches, particularly branches which bear small bracket fungi. So far it has not been found much in the area formerly covered by the Wisconsin ice sheet.

Illinois records.—Collected from May through September, from one to several localities in the following counties: ADAMS, CARROLL, CLARK, COLES, EDGAR, HARDIN, JERSEY, JOHNSON, KANE, MASSAC, OGLE, PUTNAM, ROCK ISLAND, and WHITESIDE.

***Hoplothrips fumiceps* (Hood),**
generic reassignment

Trichothrips fumiceps Hood (1925b: 29). ♀, ♂. Type-locality.—Potter, New York. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (apterous).—Length distended over 2.5 mm. Color light brownish yellow with head and terminal antennal segments brown. Antennal segment I, prothorax, sides of pterothorax, and usually abdominal segments VIII and IX light brown. Legs and antennal segments II and III yellow. Tube orange-brown tipped with gray.

Head (Fig. 243) slightly broader than long. Eyes small but with at least 10 dorsal facets, set in from outer cheek margins. Only fore ocellus present. Postocular setae moderately long and pointed. Antennal segment III with one inner and two outer sense

cones, segment VII with apical sense cone on outer lateral angle, segment VIII lanceolate. Mouth cone rounded to nearly pointed.

Prothorax with most major setae well developed, pointed; anteromarginal setae minute. Fore tarsi each with a well-developed, sharply pointed tooth. Wings completely reduced but with some axillary sclerites remaining.

Pelta roughly triangular. Abdominal tergites without especially developed wing-holding setae. Lateral abdominal setae extremely long, pointed. Abdominal tergite IX with major posterior setae long and pointed. Tube moderate in size.

MALE (brachypterous).—Unknown to me. Glandular area of abdominal sternite VIII, if present, not mentioned in original description.

Hoplothrips fumiceps can be distinguished by the orange-brown tube, the reduction of the anteromarginal setae on the prothorax, the possession of two outer sense cones on antennal segment III, and particularly by the lateral placement of the apical sense cone on antennal segment VII. Although *fumiceps* resembles *pergandei* in some respects, a comparison of the forms of the heads of the species (Fig. 243, 245, and 246) demonstrates their distinctiveness.

This species seems to be the northern equivalent of the southern *marginalis*. In contrast to *fumiceps*, *marginalis* has a predominantly brown tube and the sense cone on antennal segment VII is placed dorsally at the apex.

So far specimens have been taken only in the northern half of the state. Most were collected from dead branches.

Illinois records.—COOK COUNTY: Western Springs, June 21, 1949, Ross, Stannard, on dead willow, 1 ♀. PEORIA COUNTY: Mapleton, June 2, 1949, Stannard, dead willow branch, 1 ♀. VERMILION COUNTY: Danville, September 14, 1961, Smith, Moll, Stannard, dead branch, 1 ♀; Muncie, October 16, 1949, Sanderson, beating, 1 ♀.

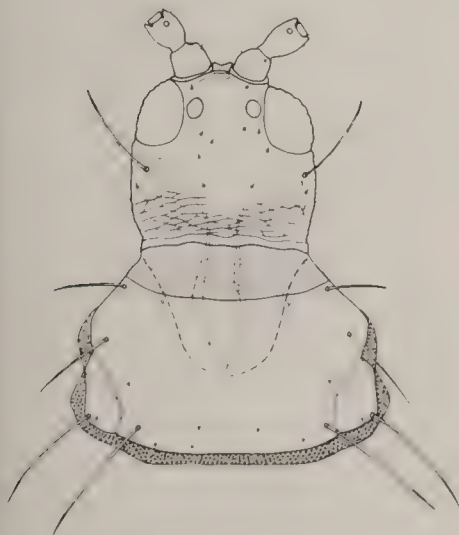


Fig. 243. —*Hoplothrips fumiceps*, head and prothorax.

Hoplothrips pergandei (Hood),
generic reassignment

Trichothrips pergandei Hood (1927e: 115). ♀, ♂. Type-locality.—Washington, D. C. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (brachypterous) (Fig. 244).
— Length distended about 2 mm. Col-

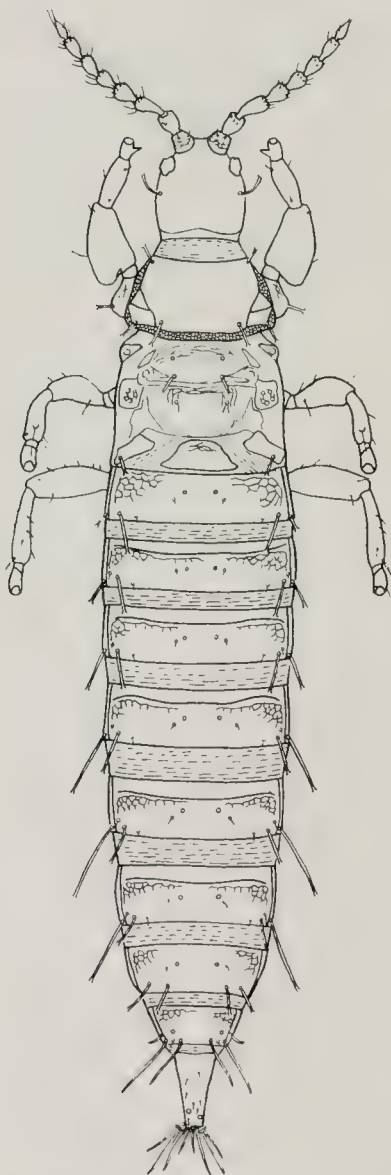


Fig. 244.—*Hoplothrips pergandei*, ♀ brachypterous, dorsal aspect.

or generally yellow to light brownish orange, tube always orange-yellow in basal half. Dark-phase individuals with brown on head in region of eyes, on mesothorax, and on sides of abdominal tergite II. Body with yellow subintegumental pigment which may appear dark gray by transmitted light.

Head (Fig. 245) about as wide as long. Eyes small with only a few dorsal facets, very much bulged from head. Ocelli absent. Postocular setae moderately long, usually dilated but occasionally seen as blunt or pointed. Antennal segments III–VIII each with a sharply narrowed pedicel, segment III with one inner and one outer sense cone, segment VII with apical sense cone placed dorsally, segment VIII decidedly lanceolate. Mouth cone relatively short and broadly rounded.

Prothorax with most major setae moderately developed, dilated; anteromarginal setae minute. Fore tarsi each with a strong, sharp tooth. Wings reduced to pads.

Pelta oval to roughly triangular.

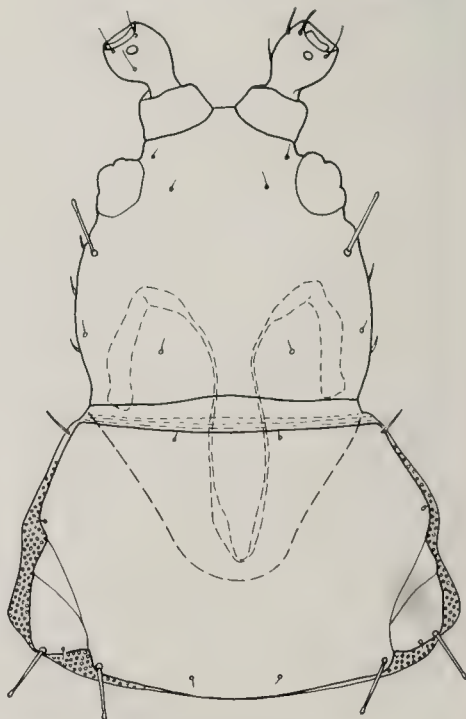


Fig. 245.—*Hoplothrips pergandei*, ♀ brachypterous, head and prothorax.

Abdominal tergites without differentiated wing-holding setae. Most lateral setae on abdominal tergites dilated (rarely blunt or pointed). Abdominal tergite IX (Fig. 53) with major setae not as long as tube, pointed. Tube relatively long, stout at base.

FEMALE (macropterous).—Length distended about 2.2 mm. Color orange-yellow with brown areas somewhat like dark phase of brachypterous female. Brown: much of head especially in region of eyes, mesothorax, sides of abdominal tergite II, and sometimes terminal antennal segments. Wings light brown.

Similar in structure to brachypterous female with the following exceptions. Eyes (Fig. 246) slightly larger but also with less than a dozen dorsal facets. Ocelli present. Wings fully developed, fore wings without accessory fringe cilia. Abdominal tergites with wing-holding setae developed, curved or slightly sigmoidal.

MALE (brachypterous).—Length distended about 1.6 mm. Similar in

color and structure to brachypterous female with the following exceptions. Usually light in color but occasionally with brown on sides of abdominal tergite II. Most males appear to be major forms having the fore legs and prothorax enlarged. Fore tarsi each with a broad, stout tooth. Abdominal sternite VIII with a median glandular area which varies from a small circle to oval to transversely elongate even in a single population. Abdominal tergite IX (Fig. 52) with major lateral posterior setae reduced in size.

This distinctive species may be separated from its congeners in Illinois by the small, bulged eyes, the lanceolate form of antennal segment VIII, the reduction of the prothoracic anteromarginal setae, and by color. According to Hood (1927*e*) the type specimens were apterous, but all of the more than 500 specimens in our collection from Illinois and other states are either macropterous or brachypterous.

Hoplothrips pergandei is common in forest leaf litter. It is found throughout Illinois except for the northernmost counties.

Illinois records.—Collected every month of the year, in one to several localities in the following counties: ADAMS, CLARK, COOK, DE KALB, DE WITT, EFFINGHAM, FAYETTE, FORD, HAMILTON, HANCOCK, HARDIN, HENDERSON, JACKSON, JEFFERSON, JERSEY, JOHNSON, KENDALL, LOGAN, MARION, MARSHALL, MASON, MONROE, MORGAN, PERRY, PIATT, POPE, PULASKI, RANDOLPH, RICHLAND, ROCK ISLAND, UNION, WASHINGTON, WAYNE, and WOODFORD.

***Hoplothrips smithi* (Hood),
generic reassignment**

Trichothrips smithi Hood (1909*a*:29).

♀. Type-locality.—Bosky Dell, Jackson County, Illinois. Transferred to *Phlaeothrips* by Stannard (1957*b*).

FEMALE (apterous) (Fig. 247).—Length distended about 1.4 mm. General color brown. Antennal segments I and II, base of segment III, and tarsi yellowish brown. Tube yellow,

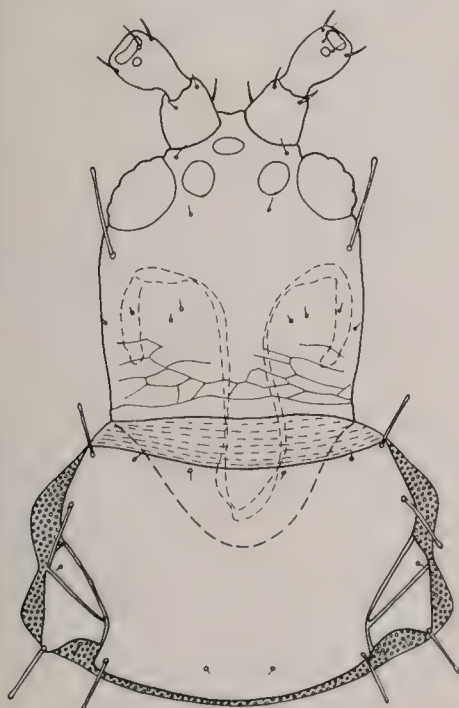


Fig. 246.—*Hoplothrips pergandei*, ♀ macropterous, head and prothorax.



Fig. 247. *Hoplothrips smithi*, dorsal aspect.
Photo by W. E. Clark.

tipped with gray. Body with red sub-integumental pigment.

Head as broad as long. Eyes small, composed of about 10 dorsal facets, slightly bulging, not inset from outer cheek margin. Ocelli absent. Postocular setae moderate in size, pointed. Antennal segments III and IV each with one outer and one inner sense cone, antennal segment VIII lanceolate. Mouth cone broadly rounded; maxillary stylets placed V-shaped within head.

Prothorax with all major setae developed but only moderate in size, blunt; anteromarginal setae small although not minute. Praepectus absent. Pterothorax without trace of wings or auxiliary sclerites. Fore tarsi each with a small tooth.

Pelta moderately developed but not as large as in apterous forms of *flavicauda*. Wing-holding setae not differentiated. Abdominal tergite IX with major lateral setae moderate in size, pointed. Tube relatively short.

MALE (apterous—minor form).—Length distended about 1.1 mm. Similar to apterous female except for following. Prothorax with anteromarginal setae minute. Fore tarsal tooth slightly longer. Abdominal tergite IX with major lateral setae reduced in size. Abdominal sternite VIII without glandular area.

This rare species is known only by a few apterous specimens, all from Illinois. It resembles *flavicauda* in many respects. Unlike *flavicauda*, *smithi* lacks praepectal plates, the maxillary stylets are placed V-shaped within the head, and the eyes are situated close to the outer cheek margins.

In a closely related, undescribed species from Costa Rica which is in our collection, major males have the fore femora and tibiae armed similarly to some males of *flavicauda*. It could be predicted, therefore, that major male forms of *smithi*, when found, may also be so armed.

This species occurs in the southern half of Illinois on dead branches.

Illinois records.—COLES COUNTY:

Fox Ridge State Park, May 18, 1950, Sanderson, Stannard, beating Hydnaceae fungi on hickory branch, 1 ♀. JACKSON COUNTY: Bosky Dell, October 20, 1908, Smith, hard maple, 2 ♀ (Hood 1909). PIKE COUNTY: Kinderhook, August 9, 1951, Richards, Stannard, dead branches, 1 ♀, 1 ♂.

Hoplothrips terminalis (Hood and Williams), generic reassignment

Trichothrips terminalis Hood and Williams (1915:130). ♀, ♂. Type-locality.—Orlando, Florida. Transferred to *Phlaeothrips* by Stannard (1957b).

FEMALE (macropterous).—Length distended about 2.8 mm. Head light brownish yellow, thorax and basal segments of abdomen brown, remainder of abdomen becoming yellow, tube yellow with a subbasal orange ring. Antennae brown at base and apex, segment III yellow, remainder of intermediate segments becoming progressively more brown. Legs yellow except base of femora.

Head about as broad as long. Eyes moderate in size, not particularly indented from outer cheek margin. Ocelli present. Postocular setae moderately long, pointed. Antennal segment III with one inner and two outer sense cones, segment IV with two inner and two outer sense cones, segment VII with apical sense cone placed dorsally, segment VIII with a narrow pedicel. Mouth cone broadly rounded.

Prothorax with all major setae well developed, pointed; anteromarginal setae nearly as long as anterolateral setae. Fore tarsi each with a well-developed, sharp tooth. Wings broken off in only specimen I have studied.

Pelta roughly triangular. Abdominal tergites with wing-holding setae only slightly developed, usually slightly curved but not particularly sigmoidal. Abdominal tergite IX with major posterior setae moderately long and pointed. Tube moderate in size.

FEMALE (brachypterous).—Described as similar to macropterous female except head more nearly yellow and eyes smaller.

MALE (brachypterous).—Similar to female. Presence or absence of abdominal sternal glandular areas not stated in protolog.

This species is another of those entities which have the anteromarginal setae of the prothorax well developed. It resembles *americanus* in many ways. In *terminalis* antennal segment IV has two inner and two outer sense cones, whereas in *americanus* antennal segment IV bears two outer sense cones but only one inner sense cone, and by this characteristic the two may be readily distinguished.

Hoplothrips terminalis was collected once from extreme southern Illinois. The sole specimen known from our state, a macropterous female, was used as the basis for my interpretation of the species. Further study of this species is especially desirable from the standpoint of its exact relationship to *americanus*.

Illinois record.—POPE COUNTY: Bell Smith Springs, July 16, 1948, Mills, Ross, 1 ♀.

Liothrips Uzel

Liothrips Uzel (1895:261). Type-species by subsequent designation by Hood (1918).—*Phloeothrips setinodis* Reuter.

Phyllothrips Hood (1908a:305). Type-species by original designation.—*Phyllothrips citricornis* Hood. Synonymized by Hood (1909b).

Hoodia Karny (1910:41). Type-species by monotypy.—*Hoodia austriaca* Karny. Synonymized by Priesner (1928).

Rhynchothrips Hood (1912c:141). Type-species by original designation.—*Rhynchothrips pruni* Hood. Synonymized by Stannard (1957b).

Head elongate to about as long as wide. Surface of head transversely striate (usually hexagonally reticulate only in region of ocelli). Eyes moderate in size to fairly large. Ocelli present although fore ocellus sometimes reduced in brachypterous forms; area bearing ocellus often prolonged to

overhang base of antennae. Postocular setae of moderate length to long, dilated, blunt or pointed. Cheeks without any strong basal setae. Antennae eight segmented; intermediate segments generally slightly elongate; segment III never with an inner sense cone, always with but one outer sense cone; segment IV elongate but subglobose in several species, always with one inner and one or two outer sense cones; segment VIII usually nonpedicellate. Mouth cone usually long, pointed to broadly rounded. Maxillary stylets retracted far into the head, nearly touching in center of head.

Prothorax weakly sculptured to nearly smooth; with major setae well developed although anterior setae smaller than posterior setae, pointed to blunt to dilated. Epimeral sutures complete. Praepectus absent. Metanotum longitudinally striate or hexagonally reticulate to weakly marked especially in the median area. Macropterous or brachypterous. Fore wings when present not indented in the middle, always with accessory fringe cilia, sometimes with considerable brown color in the basal half. Fore legs never with a tarsal tooth in species of the Illinois fauna.

Pelta small, bell shaped to triangular. Wing-holding setae sometimes weakly developed in brachypterous forms, well developed in macropterous forms. Major posterior setae on abdominal tergite IX pointed to blunt, lateral pair in males reduced and always pointed. Males usually with a broad glandular area on abdominal sternite VIII. Tube conical or slender, short to moderately long.

Although a troublesome genus, hard to define and with species difficult to distinguish, *Liothrips* in Illinois usually can be recognized by the combination of the following characteristics: lack of praepectal plates, transverse striations on head, long mouth cone, lack of an inner sense cone on antennal segment III, unarmed fore tarsi, the presence of accessory fringe cilia on the fore wings, and often by the well-marked longitudinal or elongate hexagonal sculpture of the metanotum.

In the past, the species *longitubus*

has been placed in *Hoplothrips* but this species should be transferred to *Liothrips*. It resembles *vaneeckei* very closely and *vaneeckei* is generally considered by all students to be a true, although not typical, *Liothrips*.

In Illinois, 13 species of this genus have been discovered so far. Most live on living leaf tissues, juices, or galls, and some may feed on juices of the cambium layer of trees. The exotic species, *vaneeckei*, may be looked for on imported lily bulbs. Seemingly all of our native species inhabit woodlands only.

KEY TO SPECIES

Because the macropterous form of *pruni* and *buffae* are unknown but possibly do exist, because some species known only by the macropterous form may be found to have brachypterous forms, and because the species are extremely similar, identification by means of the following key should be made with reference to a named collection.

1. Tarsi and at least apical half of all tibiae predominantly yellow; mouth cone broadly rounded; epimeral setae extremely long.....2
Tarsi and tibiae predominantly brown; mouth cone pointed; epimeral setae never as long.....3
2. Prothoracic bristles dark brown.....*vaneeckei*
Prothoracic bristles light yellow.....*longitubus*
3. Antennal segments III–VIII yellow, although segment VIII sometimes lightly shaded with brown, and metanotum strongly longitudinally striate.....*citricornis*
Antennae usually with at least segments VII and VIII dark brown; if these segments yellowish brown (probably teneral individuals), then metanotum not closely longitudinally striate; otherwise metanotum longitudinally striate, somewhat hexagonally reticulate, or fairly weakly marked.....4
4. Fore wings with a fairly extensive streak or area of brown in basal half.....5
Fore wings clear except sometimes immediately above scale; or brachypterous.....8
5. Fore wings with basal half almost entirely brown.....6
Fore wings with only a narrow median streak of brown.....7
6. Fore ocellus protruding and overhanging base of antennae.....*umbripennis*
Fore ocellus not especially protruding and not overhanging base of antennae.....*usitatus*
7. Epimeral setae usually just slightly longer than dorsal eye length; antennal seg-

- ment IV predominantly yellow.....*castaneae*
 Epimeral setae generally much longer than dorsal eye length; antennal segment IV with much brown...*sambuci*
8. Macropterous.....9
 Brachypterous.....13
9. Fore ocellus not overhanging insertion of antennae.....10
 Fore ocellus overhanging insertion of antennae.....11
10. Metanotum with longitudinal striations closely spaced medially.....*caryae*
 Metanotum with striations not as closely spaced medially.....*russelli*
11. Metanotum with elongate hexagonal reticulations.....*brevicornis*
 Metanotum with longitudinal striations.....12
12. Antennal segment III largely yellow.....*ocellatus*
 Antennal segment III predominantly brown.....*tridentatus*
13. Antennal segment IV predominantly brown although usually with some yellow at base; subglobose.....14
 Antennal segment IV usually predominantly yellow or yellowish brown, although occasionally with some brown at base; more elongate.....15
14. Median length of prothorax about equal to length of head; under cherry bark.....*pruni*
 Median length of prothorax decidedly less than length of head; rare, too few observations made to date to ascertain habitat.....*buffae*
15. Epimeral setae just slightly longer than dorsal eye length; on virginia creeper.....*russelli*
 Epimeral setae much longer than dorsal length of eye; on *Rhus copallina*.....*usitatus*

Liothrips brevicornis Hood

Liothrips brevicornis Hood (1913b: 164). ♀. Type-locality.—Vienna, Virginia.

FEMALE (macropterous).—Length distended nearly 3 mm. General color dark brown. Antennal segment III yellow, segment IV light brown at base. Fore wings colorless except for a small brown streak in region of scale. Body bristles mostly brown except extreme lateral bristles in the posterior half of the abdomen and the major posterior setae of abdominal tegite IX which are yellow.

Head longer than wide, anterior area bearing fore ocellus prolonged. Postocular setae long, blunt to nearly pointed. Antennal segment III with no inner and one outer sense cone,

segment IV with one inner and two outer sense cones. Mouth cone relatively long and pointed.

Prothorax with all major setae well developed, the posterior pairs extremely long, much longer than the dorsal eye length; all of these setae blunt. Metanotum with sculpture almost entirely in the form of elongate hexagonal reticulations. Fore tarsi unarmed. Fore wings each with about 20 accessory fringe cilia in Illinois specimens known to date.

Pelta roughly triangular. Abdominal tergite IX with major posterior setae long, as in *citricornis* and *caryae*. Tube relatively long, just slightly shorter than head.

MALE.—Unknown.

This species is easily distinguished from the Illinois fauna by the sculpture of the metanotum, which is more nearly hexagonally reticulate than longitudinally striate.

So far this species has been taken only once in our state. The type material came from *Sassafras* which may be the preferred host.

Illinois record.—**POPE COUNTY**: Bell Smith Springs Recreation Area, April 29, 1949, Sanderson, Stannard, sweeping woods, 1 ♀.

Liothrips buffae (Hood)

Trichothrips buffae Hood (1908c:369). ♀, ♂. Type-locality.—Not stated but holotype labeled Decatur, Illinois. Transferred to *Liothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended over 2 mm. General color dark brown. Pedicel of antennal segment III yellow. Apex of antennal segment II and extreme bases of all tibiae yellowish brown. Body bristles light brown.

Head about as wide as long, anterior area bearing fore ocellus scarcely prolonged. Postocular setae long, barely blunt to pointed. Antennal segment III with no inner and one outer sense cone; segment IV subglobose, with one inner and one outer sense cone. Mouth cone extremely long and pointed.

Prothorax with length along the

meson shorter than head; with major setae well developed, the posterior pairs moderately long; all these setae barely blunt to pointed. Metanotum weakly marked, predominantly with elongate hexagonal reticulations. Fore tarsi unarmed. Wings reduced to pads.

Pelta roughly bell shaped. Abdominal tergite IX with major posterior setae moderate in size, much shorter than tube, pointed. Tube slightly shorter than head.

MALE (brachypterous).—Unknown to me. In the protolog (Hood 1908) described as similar to female but no remarks were given on form of abdominal glandular areas, if any.

This species is very similar to *pruni* but differs in the relative size of the prothorax as mentioned in the key.

Although *buffae* has been known for at least 50 years, very few specimens have been collected. Only one specimen has been taken in Illinois since the year of its original discovery and the macropterous form has not been found. Besides Illinois, it has been recorded from New Jersey, New York, and Minnesota, and I have examined a male specimen from Dunn County, North Dakota, through the courtesy of Mr. G. Thomasson.

Illinois records.—CHAMPAIGN COUNTY: (Hood 1908). IROQUOIS COUNTY: Milford, September 18, 1962, Smith, Braasch, Stannard, beaten from dead branch, 1 ♀. MACON COUNTY: Decatur, February 22, 1908, Zetek, Gates, under bark on soft maple tree, 1 ♀ paratype.

***Liothrips caryae* (Fitch)**

Phloeothrips caryae Fitch (1856:445). ? ♀. Type-locality.—State of New York. Transferred to *Liothrips* by Hood (1914b).

Liothrips caryae floridensis Watson (1916:130). ♀, ♂. Type-locality.—Gainesville, Florida. New synonymy.

Liothrips dendropogonis Watson (1938:14). ♀. Type-locality.—Gainesville, Florida. New synonymy.

FEMALE (macropterous).—Length distended about 3 mm. General color dark brown. Antennal segment III yel-

low, often lightly clouded with brown at apex. Bases of antennal segments IV–VI and tarsi sometimes lighter brown to yellowish brown. Setae of head, thorax, and anterior part of abdomen light brown; lateral setae of posterior part of abdomen and posterior setae of abdominal tergite IX yellow. Fore wings clear except for a minute, brown median streak in region of scale. Body with much red subintegumental pigment.

Head just slightly longer than wide, anterior area bearing fore ocellus not prolonged or just slightly prolonged. Postocular setae moderately long, blunt to nearly pointed. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone moderately long and pointed.

Prothorax with all major setae well developed, long, the posterior pairs longest, nearly twice as long as the dorsal eye length, all blunt to nearly pointed. Metanotum with median portion longitudinally striate and with lateral portion elongate, hexagonally reticulate. Fore tarsi unarmed. Fore wings each with 20–24 accessory fringe cilia.

Pelta narrowly triangular. Abdominal tergite IX with major posterior setae long and pointed. Tube relatively long, just slightly shorter than head.

MALE (macropterous).—Length distended about 2.7 mm. Similar to female except for the following. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with the major lateral setae short.

This species differs from *brevicornis*, which it resembles, by having the anterior area of the head not much prolonged, the central portion of the metanotum longitudinally striate instead of elongate and hexagonally reticulate, and the pelta more narrowed. The lack of a projecting fore ocellus makes *caryae* appear similar to many species of the subgenus *Rhynchothrips*.

So far this species has been found in the western, central, and southern parts of our state.

Illinois records.—CLARK COUNTY: Clarksville (Rocky Branch Natural Area), June 14, 1950, Sanderson, Stan-

nard, 1 ♀. DOUGLAS COUNTY: Arcola, October 12, 1949, Stannard, ground cover, 2 ♂. GALLATIN COUNTY: Gibsonia (Pounds Hollow), April 24, 1963, Stannard, 1 ♀; Saline Mines, May 7, 1959, Sanderson, *Carya*, 4 ♀. HENDERSON COUNTY: Oquawka, May 9, 1959, Stannard, on *Carya* leaves, 3 ♀, 3 ♂. JACKSON COUNTY: Giant City State Park, April 27, 1949, Sanderson, Stannard, on *Rhus* bud, 1 ♀. JOHN-SON COUNTY: Bell Smith Springs Recreation Area, May 5, 1950, Sanderson, Stannard, sweeping grass, 1 ♀; Ozark, May 5, 1950, Sanderson, Stannard, sweeping grass, 1 ♂. MASON COUNTY: Mason State Forest, May 21, 1953, Moore, on *Quercus stellata*, 1 ♀. PIATT COUNTY: Monticello, March 28, 1938, Farrar, woodland debris, 1 ♀, 1 ♂. POPE COUNTY: Herod, May 4, 1950, Sanderson, Stannard, *Cornus* leaves, 2 ♀, 2 ♂; Rock, May 6, 1950, Sanderson, Stannard, dead *Salix*, 1 ♀. WHITE COUNTY: Enfield, October 12, 1933, Frison, Ross, log in woods, 1 ♂.

***Liothrips castaneae* Hood**

Liothrips castaneae Hood (1915d:76).
♀, ♂. Type-locality.—Bluemont, Virginia.

FEMALE (macropterous).—Length distended about 2.2 mm. General color dark brown. Antennal segments III, IV (except sides at apex which are sometimes lightly shaded with brown), and pedicel of V yellow. Body bristles brown. Fore wings clear except for a brown, narrow, median streak in basal half. Body with red subintegumental pigment.

Head longer than broad, anterior area bearing fore ocellus prolonged, overhanging base of antennae. Post-ocular setae moderately long, blunt. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone relatively long and pointed.

Prothorax nearly smooth, striations not as strongly marked as in *ocellatus*; with all major setae well developed, moderate in size (epimeral setae just slightly longer than dorsal eye length),

all blunt. Metanotum with closely spaced longitudinal striae, not forming elongate hexagonal reticulations even at sides. Fore tarsi unarmed. Fore wings each with 10–12 and possibly 14 accessory fringe cilia.

Pelta triangular. Abdominal tergite IX with major posterior setae much shorter than tube, blunt. Tube moderately long, three-fourths as long as head.

MALE (macropterous).—Length distended about 2.1 mm. Similar to female except for the following. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with major lateral setae much shorter.

This species can be distinguished by the characteristics given in the key. From *sambuci*, which it resembles, *castaneae* can be recognized by antennal segment IV, which is usually predominantly yellow, not predominantly brown; by the shorter epimeral setae; by the metanotum, which has the striae more closely spaced; and by the fore wing streak which is shorter and weaker.

Although presumed by Hood (1915d) to be “an exclusive feeder on chestnut,” this species (adults as well as larvae) is found on oak leaves, particularly *Quercus macrocarpa*, in Illinois. Besides specimens from our state, I have seen a male from Arvilla, North Dakota, indicating that *castaneae* has a wide range from the East Coast to a few degrees east of the 100th meridian.

ILLINOIS RECORDS.—CHAMPAIGN COUNTY: St. Joseph, May 20, 1948, Sanderson, Becker, Stannard, sweeping *Quercus*, 2 ♀, 2 ♂, 3 larvae. KANKAKEE COUNTY: Kankakee, July 28, 1949, Ross, Stannard, on *Quercus macrocarpa*, 7 ♀, 5 ♂. LA SALLE COUNTY: Starved Rock State Park, November 8, 1943, Ross, Sanderson, old log, 1 ♂; July 9, 1952, Smith, Stannard, dead branches, 1 ♀. OGLE COUNTY: Brookville, June 22, 1948, Stannard, *Quercus* leaves, 1 ♂, 1 larva. PIATT COUNTY: Monticello, August 20, 1948, Ross, Stannard, on *Quercus macrocarpa*, 6 ♀, 7 ♂, 3 larvae. VERMILION COUNTY: Kickapoo State Park, October 3, 1948, Ross, *Quercus macrocarpa*, 1 ♀.

***Liothrips citricornis* (Hood)**

Phyllothrips citricornis Hood (1908a: 305). ♀. Type-locality.—Not stated, but holotype labeled Du-bois, Illinois. Transferred to *Lio-thrips* by Hood (1909b).

Liothrips flavoantennis Watson (1916:

129). ♀. Type-locality.—Gainesville, Florida. Synonymized by Hood (1927b); see also discussion here.

FEMALE (macropterous) (Fig. 248).—Length distended nearly 3 mm. General color dark brown. Antennal

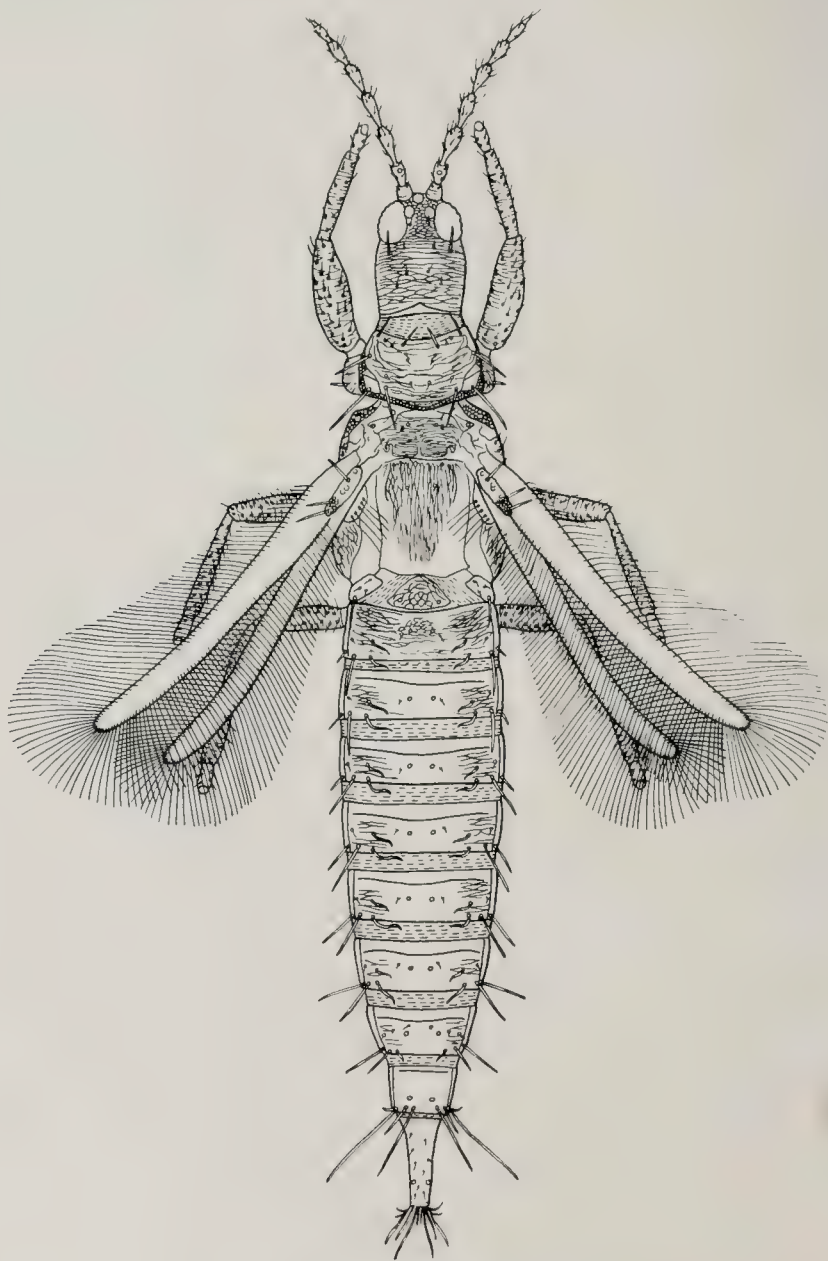


Fig. 248.—*Liothrips citricornis*, dorsal aspect.

segments III–VIII bright yellow except sometimes VII and VIII lightly shaded with brown. Tarsi often lighter brown. Fore wings clear except for a small, brown, median streak in region of scale. Body bristles brown to brownish yellow except extreme lateral setae of posterior half of abdomen and major setae of abdominal tergite IX which are yellow.

Head (Fig. 249) longer than wide, anterior area bearing fore ocellus prolonged. Postocular setae long, blunt to dilated. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone relatively long and pointed.

Prothorax with all major setae well developed, fairly long (epimeral setae the longest, much longer than the dorsal eye length), all blunt to dilated. Metanotum with closely spaced longitudinal striae, hardly forming elongate hexagonal reticulations even at sides. Fore tarsi unarmed. Fore wings each with 10–14 accessory fringe cilia.

Pelta (Fig. 250) triangular to bell shaped. Abdominal tergite IX with major posterior setae long and pointed. Tube (Fig. 190) moderately long.

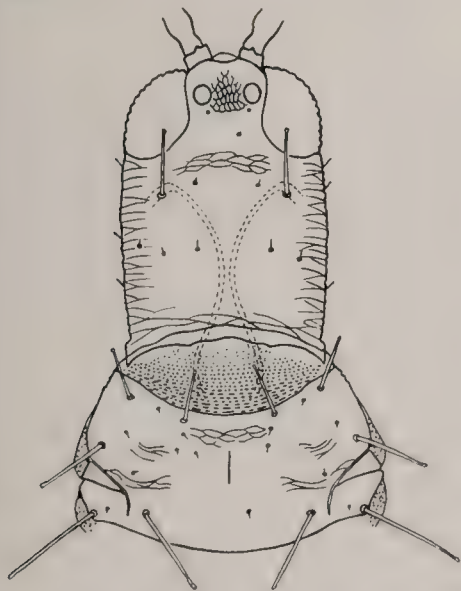


Fig. 249.—*Liothrips citricornis*, head and prothorax.

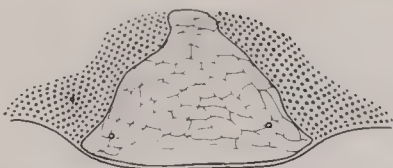


Fig. 250.—*Liothrips citricornis*, pelta.

MALE (macropterous).—Length distended about 2.2 mm. Similar to female except for the following. Abdominal sternite VIII with an extremely broad glandular area almost covering the entire ventral surface. Abdominal tergite IX with the major lateral setae shorter.

This is the only species in Illinois in which the legs are dark and antennal segments III–VIII are predominantly yellow.

In 1927 Hood sank *flavoantennis* Watson under *citricornis* on the basis of a male, not of the type series (being collected four years after appearance of the original description), which is now deposited in the U. S. National Museum. Although this specimen is assignable to *citricornis*, a female paratype of *flavoantennis*, also at the USNM, is seemingly better assigned to *floridensis*, the camphor thrips. The holotype of *flavoantennis* was to have been deposited in the USNM, but no such marked slide is there at present. A specimen in the Watson collection at Gainesville, Florida, from the type series, is designated here to be the lectotype. The specimen involved is a female in the center of the slide and is a true *citricornis*. The lectotype slide is labeled "Gainesville, Fla., on grape, 4-22-'14." The word "flavoantennis" is marked in crayon on the glass and "citricornis" is marked on the paper label. Watson published the date as April 23, not 22, but probably either the date on the slide or the published number is an inadvertent error.

Liothrips citricornis is found mostly on hickory and grape but sometimes also on other plants. It is common throughout most of Illinois as well as in most of the eastern states.

Illinois records.—Collected every month of the year (in winter in hibernation in the forest leaf mold), from

one to several localities in the following counties: ADAMS, ALEXANDER, CARROLL, CLARK, CLAY, CLINTON, COLES, CUMBERLAND, DE WITT, EFFINGHAM, HARDIN, HENDERSON, HENRY, JACKSON, JEFFERSON, JERSEY, JO DAVIESS, JOHNSON, MADISON, MARION, MASON, McDONOUGH, MONROE, MOULTRIE, OGLE PERRY, PIATT, POPE, PULASKI, PUTNAM, RANDOLPH, ST. CLAIR, UNION, VERMILION, WASHINGTON, WAYNE, and WINNEBAGO.

***Liothrips longitubus* (Hood)**

Trichothrips longitubus Hood (1908c: 368). ♀, ♂. Type-locality.—Carbondale, Illinois. New combination.

FEMALE (macropterous).—Length distended about 2.1 mm. General color dark brown. Tibiae yellowish brown becoming yellow at apex. All tarsi and antennal segments III–VI yellow. Body setae light yellow. Fore wings clear except for a light brown cloud in region of basal setae.

Head just slightly longer than broad, anterior area bearing fore ocellus slightly prolonged. Postocular setae extremely long, blunt. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone long, broadly rounded.

Prothorax with all major setae well developed, lateral and posterior setae extremely long, epimeral setae about three times as long as dorsal eye length, anterior setae blunt, posterior setae pointed. Metanotum weakly marked with elongate hexagonal reticulations, median portion bare. Fore tarsi unarmed. Fore wings each with 9–11 accessory fringe cilia.

Pelta triangular. Abdominal tergite IX with major setae extremely long, much longer than tube, pointed. Tube long, about as long as head.

MALE (macropterous).—Unknown to me. In the protolog it was stated that the male was similar to the female, but no remarks were given on the condition of the abdominal glandular area if present.

Point by point *longitubus* is remarkably similar to *vaneckeai*. Both have

light-colored legs, long body setae, broadly rounded mouth cones, similarly marked metanota, and long tubes. In some of these characteristics, these two species are transitional between *Liothrips* and *Gynaikothrips*. Unlike *vaneckeai*, *longitubus* has light yellow prothoracic setae and longer postocular setae. By these features the two can be easily distinguished.

This rare species was originally collected by Charles A. Hart at Carbondale, Illinois. We have taken several more specimens since. Apparently these records are the only ones known in this state or elsewhere.

Its biology is unknown.

Illinois records.—CLARK COUNTY: Clarksville (Rocky Branch Natural Area), June 8, 1954, Evers, Stannard, on Virginia creeper, 1 ♀. JACKSON COUNTY: Carbondale, May 19, 1908, Hart, sweepings along railroad track, 10 ♀, 1 ♂ (Hood 1908). PUTNAM COUNTY: June 13, 1956, Glenn, Selander, Stannard, beating dead branch in bottom woods, 1 ♀.

***Liothrips ocellatus* Hood**

Liothrips (?) *ocellatus* Hood (1908c: 375). ♀. Type-locality.—Hillery, Vermilion County, Illinois.

FEMALE (macropterous).—Length distended about 2 mm. General color dark brown. Antennal segments III, IV, and basal half of V yellow. Body bristles brown becoming light brown to yellow in those on abdominal tergite IX. Fore wings clear except for brown spot at extreme base in region of scale. Body with red subintegumental pigment.

Head slightly longer than wide, anterior area bearing fore ocellus prolonged and overhanging base of antennae. Postocular setae moderate in size, blunt to dilated. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone relatively long, pointed.

Prothorax fairly well marked by anastomosing striations; with all major setae well developed, moderate in size, the posterior pairs being slightly longer than the others, about the same

as the dorsal eye length; all these setae blunt to dilated. Metanotum almost entirely with closely spaced longitudinal striations. Fore tarsi unarmed. Fore wings each with 10–14 accessory fringe cilia.

Pelta triangular, reticulate. Abdominal tergite IX with major setae moderate in size, dilated. Tube more than three-fourths as long as head.

MALE (macropterous).—Length distended about 2 mm. Similar in form and color to female. Fore tarsi unarmed. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with major lateral setae shorter, spinelike, pointed.

Except for the absence of a long, basal, brown streak on the fore wing, *ocellatus* closely resembles *castaneae*. In *ocellatus*, however, antennal segments IV and V are more yellow and the pronotal striations are more conspicuously marked than as in *castaneae*.

Although only limited data are available, it may be surmised that this species is another of those that have barely entered the area covered by the Wisconsin ice sheet in Illinois. Its habits are unknown.

Illinois records.—COOK COUNTY: Orland Park, April 2, 1959, Suter, black oak tree crotch, 1 ♀. HARDIN COUNTY: Karbers Ridge (Kaskaskia Experimental Forest), August 28, 1952, Richards, Stannard, 1 ♀. HENDERSON COUNTY: Oquawka, May 9, 1952, Stannard, sweeping, 1 ♂. JOHNSON COUNTY: Ferne Clyffe State Park, August 27, 1952, Stannard, jewel weed, 1 ♀; Sandburn, September 20, 1949, Smith, Stannard, ground cover, 1 ♂. UNION COUNTY: Alto Pass, January 10, 1945, Ross, Burks, ground cover, 1 ♀. VERMILION COUNTY: Hilery (Hood 1908c).

***Liothrips pruni* (Hood)**

Rhynchothrips pruni Hood (1912c: 142).—♀, ♂. Type-locality.—Not stated but holotype labeled Urbana, Illinois. Transferred to *Liothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended about 1.7 mm. General color dark brown. Basal antennal segments,

base of tibiae, and all tarsi yellow to yellowish brown. Body with red sub-integumental pigment.

Head about as wide as long, anterior area bearing fore ocellus not prolonged. Ocelli present but fore ocellus reduced. Postocular setae moderately long, pointed. Antennal segment III with no inner and one outer sense cone; segment IV subglobose, with one inner and one outer sense cone. Mouth cone extremely long and pointed.

Prothorax with median length fully as long as length of head; with major setae developed, the epimeral setae moderately long, all pointed. Metanotum short, weakly marked with elongate hexagonal reticulations. Fore tarsi unarmed. Wings reduced to pads.

Pelta broadly triangular. Wing-holding setae weakly developed. Abdominal tergite IX with major setae moderately long, pointed. Tube moderate in size, slightly shorter than head.

MALE (brachypterous).—Length distended about 1.5 mm. Similar to female except for the following. Abdominal sternite VIII seemingly with a broad glandular area. Abdominal tergite IX with the major lateral setae shorter.

This species is much like *buffae* in most respects. The two can be differentiated principally by the relative size of the prothorax, as stated in the key.

The majority of the known specimens of *pruni* have been collected from under cherry bark. Few have been found in Illinois, but presumably this species is common and statewide in distribution. It is difficult and tedious to collect.

Illinois records.—CHAMPAIGN COUNTY: Urbana (Hood 1912c). COOK COUNTY: Riverside (Hood 1912c). HARDIN COUNTY: Eichorn, August 17, 1951, Ross, Stannard, under cherry bark, 1 ♀. JACKSON COUNTY: Carbondale (Hood 1912c). LEE COUNTY: Maytown, Stannard, under cherry bark, several specimens. MCLEAN COUNTY: Lake Bloomington, August 26, 1949, Smith, Stannard, under cherry bark, 3 ♀. PULASKI COUNTY:

Pulaski (Hood 1912c). PUTNAM COUNTY: Mark, April 29, 1948, Stannard, under cherry bark, 3 ♂. VERMILION COUNTY: Oakwood, April 18, 1948, Burks, Stannard, under cherry bark, 1 ♀, 1 ♂.

Liothrips russelli (Hood)

Rhynchothrips russelli Hood (1925b: 31). ♀, ♂. Type-locality.—Beltsville, Maryland. Transferred to *Liothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended over 2.1 mm. General color dark brown. Antennal segments light brown to yellowish brown. Legs with apices of all femora, apices of fore tibiae, and all tarsi yellow to yellowish brown, the fore tarsi being almost completely yellow.

Head (Fig. 251) slightly longer than wide, anterior area bearing fore ocellus not prolonged. Ocelli present but fore ocellus often greatly reduced. Postocular setae moderate in size, blunt. Antennal segment III with no inner and one outer sense cone; segment IV not subglobose, with one inner and one outer sense cone. Mouth cone moderately long, pointed to nearly blunt.

Prothorax (Fig. 251) with median

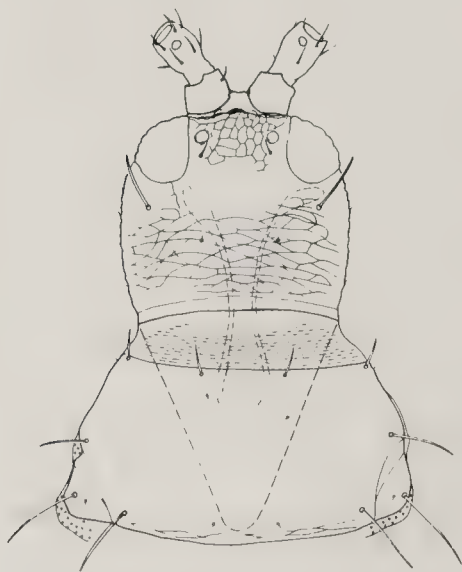


Fig. 251. *Liothrips russelli*, head and prothorax.

length shorter than head; with major setae well developed, the epimeral setae just slightly longer than dorsal eye length, all blunt to barely pointed. Metanotum short, weakly marked with elongate hexagonal reticulations. Fore tarsi unarmed. Wings reduced to pads.

Pelta roughly triangular. Wing-holding setae weakly developed. Abdominal tergite IX with major posterior setae moderate in size, much shorter than tube, pointed. Tube shorter than head.

FEMALE (macropterous).—Length distended about 2.4 mm. Similar to brachypterous female with the following exceptions. Ocelli always fully developed. Metanotum longer. Fore wings fully developed, clear except for area above scale at extreme base which is brown, with 8–10 accessory fringe cilia. Wing-holding setae well developed.

MALE (brachypterous).—Length distended about 1.7 mm. Similar to female with the following exceptions. Abdominal tergite IX with the major lateral setae shorter. Abdominal sternite VIII with condition of glandular area not determinable in specimens available to me.

This species is extremely close to *usitatus*, differing principally in the characteristics mentioned in the key. In particular, the fore wings of *russelli* are clear except for a small area at the extreme base, whereas in *usitatus* the fore wings are largely brown in the basal half.

Apparently *russelli* occurs throughout Illinois on the underside of leaves of Virginia creeper (*Parthenocissus quinquefolia*) (Fig. 35).

Illinois records.—Collected in summer, from one to several localities in the following counties: HENDERSON, HENRY, JACKSON, KNOX, MERCER, POPE, UNION, VERMILION, and WABASH.

Liothrips sambuci Hood

Liothrips sambuci Hood (1913b:163). ♀. Type-locality.—Laurel, Maryland.

FEMALE (macropterous).—Length

distended about 2.8 mm. General color dark brown. Antennal segment III yellow, segment IV more brown than in *castaneae* but yellow in pedicel becoming yellowish brown in basal third to brown in the apex. Fore wings clear with a long, brown median streak in the basal half, wider than the streak found in *castaneae*. Body bristles, including the lateral setae on the posterior part of the abdomen, brown. Body with red subintegumental pigment.

Head longer than wide, anterior area bearing fore ocellus produced, overhanging base of antennae. Postocular setae long, blunt. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone moderately long, pointed.

Prothorax with major anterior setae relatively short, lateral and posterior setae long, the epimeral pair being much longer than the dorsal eye length, all of these setae blunt to nearly pointed. Metanotum longitudinally striate becoming hexagonally reticulate along sides. Fore tarsi unarmed. Fore wings each with about 12 accessory fringe cilia.

Pelta triangular. Abdominal tergite IX with major posterior setae relatively short, shorter than in *citricornis* and *caryae*, blunt to nearly pointed. Tube moderately long, about three-fourths as long as head.

MALE (macropterous).—Length distended about 2.1 mm. Similar to female except for the following. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with major lateral setae shorter, pointed.

The broader brown streak in the fore wings, the darker color of antennal segment IV, and the longer epimeral setae of the prothorax of *sambuci* should permit easy separation of this species from *castaneae*.

Contrary to its name, this species has been found only on dogwood (*Cornus*), not *Sambucus*, in Illinois.

Illinois records.—ADAMS COUNTY: Lima, June 24, 1948, Stannard, from *Cornus*, 6 ♀, 5 ♂, 2 larvae. FULTON COUNTY: Banner, June 2, 1949, Stannard, from *Cornus drummondii*, 3 larvae.

***Liothrips tridentatus* (Shull)**

Trichothrips tridentatus Shull (1909: 226). ♀. Type-locality.—Huron County, Michigan. Transferred to *Liothrips* by Stannard (1957b).

Liothrips leucogonis Hood (1915d:78). ♀, ♂. Type-locality.—Plummer's Island, Maryland. New synonymy.

FEMALE (macropterous).—Length distended about 2.1 mm. Color generally dark brown. Apex or apical half of antennal segment II and inner apical angle of all femora light yellow. Antennal segments III and IV sometimes with light brown areas especially apically. Fore wings clear except shaded brown at extreme base. Body with red subintegumental pigment.

Head about as long as broad, anterior area bearing fore ocellus just slightly prolonged. Eyes relatively small compared to those of others originally assigned to *Liothrips*. Postocular setae moderate in size, blunt. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone extremely long and pointed.

Prothorax with all major setae well developed, moderate in size, the posterior pairs the longest, all blunt to nearly dilated. Metanotum predominantly longitudinally striate. Fore tarsi unarmed. Fore wings each with 8–12 accessory fringe cilia.

Pelta triangular. Abdominal tergite IX with major posterior setae moderate in size, blunt. Tube short compared to those of other species in this subgenus, but in a relative sense long, being slightly less than three-fourths as long as the head.

MALE (macropterous).—Length distended about 1.9 mm. Similar to female with following exceptions. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with the major lateral setae shorter and pointed.

The dark color of antennal segment III and the extremely long mouth cone are characteristics which easily distinguish this species from others in the old concept of the genus. By contrast, however, the long mouth cone and other features show that *tridentatus*

tus is close to those that were placed in *Rhynchothrips*, and could well be placed with them just as reasonably. I have assigned *tridentatus* to the typical *Liothrips* subgroup principally because it bears longitudinal metanotal striations similar to those of *citricornis*, *ocellatus*, etc.

This species is most common in the northern half of the state.

Illinois records.—Collected from late April to September, mostly on leaves of *Quercus macrocarpa*, from one to several localities in the following counties: BUREAU, CHAMPAIGN, COOK, DE WITT, GALLATIN, KANKAKEE, LEE, MONROE, RANDOLPH, SANGAMON, and WHITESIDE.

Liothrips umbripennis (Hood)

Phyllothrips umbripennis Hood (1909a:30). ♀, ♂. Type-locality.—Carbondale, Illinois. Transferred to *Liothrips* by Stannard (1957b).

FEMALE (macropterous).—Length distended about 2.5 mm. General color dark brown. Antennal segment III yellow, segment IV yellow in basal half clouded with brown at apex, segment V yellow in basal third. Fore wings with a broad brown band in basal half, clear in the remaining portions. All body bristles dark brown. Body with red subintegumental pigment.

Head longer than wide, anterior area bearing fore ocellus prolonged. Postocular setae moderate in size, blunt. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone relatively long, pointed.

Prothorax with all major setae well developed, moderate in size, the posterior pairs being the longest, just slightly longer than dorsal eye length; all of these setae blunt. Metanotum predominantly longitudinally striate. Fore tarsi unarmed. Fore wings each with about 14 accessory fringe cilia.

Pelta triangular, broad at base. Abdominal tergite IX with major posterior setae moderate in size, blunt. Tube moderate in size, about two-thirds the length of the head.

MALE (macropterous).—Length

distended about 2.3 mm. Similar to female except for the following. Abdominal sternite VIII with a broad glandular area. Abdominal tergite IX with major lateral setae shorter and pointed.

This species is distinctive in having a broad basal brown band in the fore wing and a strongly protruding fore ocellus.

So far *umbripennis* has been found in Illinois only in the central and southern parts, possibly as a feeder on leaves of the white oak group.

Illinois records.—CALHOUN COUNTY: Beecreek, August 10, 1951, Richards, Stannard, dead branch, 1 ♀. CUMBERLAND COUNTY: Neoga, September 2, 1955, Ross, Smith, Stannard, on *Symphoricarpos*, 1 ♀. HARDIN COUNTY: Elizabethtown, May 4, 1950, Sanderson, Stannard, dead branch, 1 ♀. POPE COUNTY: Rock, May 6, 1950, Sanderson, Stannard, white oak leaves, 6 ♀, 3 ♂; Bell Smith Springs Recreation Area, March 14, 1961, Evers, Stannard, forest edge, 1 ♀. SANGAMON COUNTY: Springfield, September 8, 1955, Stannard, dead branch, 1 ♀. UNION COUNTY: Ware, Atwood Ridge, October 24, 1957, Sanderson, forest leaf litter, 1 ♀. WHITE COUNTY: Norris City, March 30, 1957, Mockford, forest leaf litter, 1 ♀.

Liothrips usitatus (Hood)

Rhynchothrips usitatus Hood (1927e: 113). ♀, ♂. Type-locality.—Rock Creek Park, Washington, D. C. Transferred to *Liothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended about 2.1 mm. General color dark brown. Antennal segments yellow to yellowish brown becoming dark brown in segments VII and VIII. Inner apical angle of femora and all tarsi yellow to yellowish brown. Body with red subintegumental pigment.

Head wider than long, anterior area bearing fore ocellus not prolonged. Postocular setae slightly longer than as in *russelli*, blunt. Antennal segment III with no inner and one outer sense cone; segment IV not subglobose,

with one inner and two outer sense cones. Mouth cone long and pointed.

Prothorax with median length shorter than head; with major setae well developed, the epimeral setae much longer than dorsal eye length, all blunt. Metanotum faintly marked with elongate hexagonal reticulations. Fore tarsi unarmed. Wings reduced to pads.

Pelta (Fig. 252) roughly triangular. Wing-holding setae moderately developed. Abdominal tergite IX with major posterior setae moderate in size, slightly shorter than tube, pointed. Tube short.

FEMALE (macropterous).—Length distended about 2.2 mm. Similar to brachypterous female with following exceptions. Metanotum longer. Fore wings fully developed, brown in the basal two-thirds, each with 8–10 accessory fringe cilia. Wing-holding setae well developed.

MALE (brachypterous).—Length distended about 1.7 mm. Similar to brachypterous female except for the following. Abdominal sternite VIII seemingly with a broad glandular area. Abdominal tergite IX with major lateral setae shorter.

MALE (macropterous).—Length distended about 1.8 mm. Similar to macropterous female except for the secondary sexual characteristics mentioned under the brachypterous male.

This species resembles *russelli* but differs in the characteristics mentioned in the key. In the dark color of the basal two-thirds of the fore wings, *usitatus* is closest to *debilis*, a species not known to occur in the Midwest.

Apparently *usitatus* is host specific to *Rhus copallina* and both host and insect are confined to the southern half of the state except for an area south and east of Chicago into Iroquois County where *Rhus copallina* grows and where its thrips may be eventually found.

Illinois records.—JACKSON COUNTY: Giant City State Park, April 27, 1949, Sanderson, Stannard, on opening buds of *Rhus copallina*, 15 ♀, 2 ♂; Makanda, July 14, 1948, Sanderson, Stannard, sweeping, 1 ♂. MONROE COUNTY: Burksville, June 29, 1949, Smith, Stannard, on *Rhus copal-*



Fig. 252. *Liothrips usitatus*, pelta.

lina, 6 ♀, 5 ♂. POPE COUNTY: Herod, May 4, 1950, Sanderson, Stannard, on *Rhus copallina*, 7 ♀. WAYNE COUNTY: Zenith, May 17, 1966, Stannard, on *Rhus copallina*, 2 ♀.

***Liothrips vaneekerei* Priesner** Lily Bulb Thrips

Liothrips vaneekerei Priesner (1920b: 211). ♀, ♂. Type-locality.—Alphen, Netherlands.

FEMALE (macropterous).—Length distended about 2.5 mm. General color dark brown. Antennal segment III yellow, segments IV–VI yellowish in base, clouded with brown in the apical one-half, two-thirds, and three-fourths, respectively. Fore tibiae, apical half of mid and hind tibiae, and all tarsi yellow. Fore wings generally clear except for base, including scale, and a faintly marked, long median streak, which are brown. Body bristles brown except for major setae on posterior of abdominal tergite IX which are yellow to colorless.

Head much longer than broad, anterior area bearing fore ocellus slightly prolonged. Postocular setae moderately long, nearly pointed. Antennal segment III with no inner and one outer sense cone, segment IV with one inner and two outer sense cones. Mouth cone moderately long, bluntly rounded.

Prothorax with major setae well developed, lateral and posterior setae extremely long, epimeral setae more than twice as long as dorsal eye length; all these setae pointed or nearly pointed. Metanotum weakly marked with more or less longitudinal striations. Fore tarsi unarmed. Fore wings each with about nine accessory fringe cilia.

Pelta triangular, slightly emarginate medially on the posterior. Abdominal tergite IX with major setae

extremely long and pointed. Tube moderately long, over three-fourths as long as head.

MALE (macropterous).—Length distended about 2.3 mm. Similar to female except for the following. Abdominal sternite VIII with a broad bandlike area. Abdominal tergite IX with major lateral setae reduced.

The lily bulb thrips, an immigrant of unknown origin (Bailey 1939a), is easily recognized by the yellow color of the legs, the broadly rounded mouth cone, and the dark prothoracic bristles. Bailey (1939a) has given an account of the life history and distribution of this economic pest.

Possibly *vaneckeae* may be introduced into our state in shipments of lily bulbs. It was once reported from Indiana (Bailey 1940). To my knowledge it has not yet been found in Illinois.

Lispothrips O. M. Reuter

Lispothrips O. M. Reuter (1899:17, 26). Type-species by monotypy.—*Lispothrips wasastjernae* [sic] O. M. Reuter.

Head slightly longer than wide, transversely striate with anastomosing striae. Cheeks roughly serrate with several pairs of small, stout setae. Eyes moderate in size to somewhat reduced, slightly bulged. Ocelli present or absent. Postocular setae moderately developed. Antennae eight segmented; segment III small, subequal to IV, lacking sense cones; segment IV with at least one inner and one outer sense cone; segment VIII elongate, slender, nonpedicellate. Mouth cone long, blunt to pointed. Maxillary stylets slender, extended far into head when in repose, spaced close to moderately apart within the center of the head. Maxillary bridge small or well developed.

Thorax smooth to weakly sculptured. Prothorax with epimeral sutures incomplete to complete, praepectus absent, propinasternum sometimes greatly reduced. Mesospinasternum lacking. Usually brachypterous, rarely macropterous. Fore wings,

when developed, without accessory cilia.

Abdomen with pelta (Fig. 169) fairly broad, with transverse, anastomosing striae, larger in wingless forms than in winged forms. Wing-holding setae weakly developed in macropterous forms, not developed in brachypterous forms. Lateral abdominal setae fairly short, pointed to dilated. Abdominal tergite IX with major posterior setae short, lateral pair reduced in male more than in female. Tube moderate in size, nearly equal to head.

This holarctic genus is difficult to define and recognize, as witness the questionable assignment by Hood of one species to *Rhynchothrips* and the description by Shull of another in *Trichothrips*. The small size of antennal segment III, the lack of sense cones on that segment, the rough serrate cheeks, the brachypterous form, and the lack of praepectal plates are a combination of characteristics that help distinguish this genus in the eastern half of the United States.

In the northeastern states, *brevicruralis*, which closely resembles *crassipes*, has been recorded. In the East and South, *salicarius* has been collected from possibly four states. It is expected that at least *salicarius* may be found in Illinois with continued search.

Lispothrips salicarius Hood

Rhynchothrips (?) *salicarius* Hood (1913b:164). ♀. Type-locality.—Plummer's Island, Maryland. Transferred to *Lispothrips* by Stannard (1957b).

Lispothrips varicornis Moulton (1929b:240). ♀. Type-locality.—Menard, Texas. New synonymy.

FEMALE (brachypterous).—Length distended slightly over 2 mm. General color dark, nearly blackish brown. Antennal segment II, pedicel and often base of segment III, and extreme inner apexes of fore tibiae yellow to yellowish brown. Body setae hyaline.

Head as in Fig. 253. Eyes decidedly shorter ventrally than dorsally. Ocelli absent. Postocular setae dilated. Max-

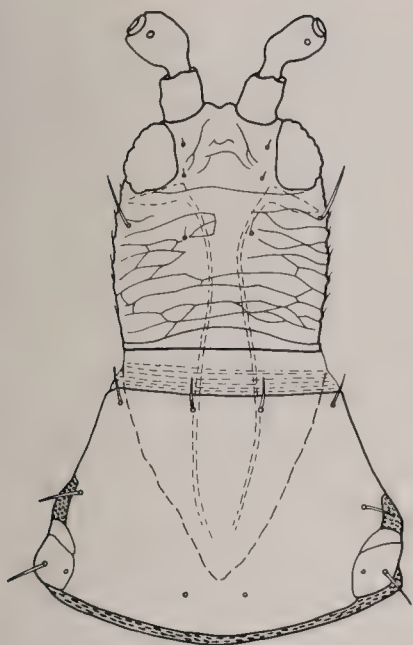


Fig. 253.—*Lissothrips salicarius*, head and prothorax.

illary stylets nearly touching medially within head. Mouth cone pointed.

Prothorax with all major setae fairly well developed, blunt to dilated. Epimeral sutures complete or almost complete. Fore wings reduced to minute pads, hind wings apparently absent. Fore tarsi unarmed. Mid and hind tibiae each with a long, outer apical seta which is blunt; this seta nearly equal in length to the tarsal segments.

Pelta wide, extending laterally to a position over the outer margins of the hind coxae. Abdomen broad. Abdominal tergite VIII with major posterior setae pointed. Tube nearly equal to head; anal setae two-thirds as long as tube.

MALE (brachypterous).—Length distended about 1.6 mm. Similar to female in general color and structure. Fore tarsi unarmed. Abdominal sternite VIII lacking a glandular area. Abdominal tergite IX with major lateral setae reduced, spinelike.

This species differs from *crassipes*, and *brevicruralis*, which may be a synonym, by the long subterminal setae on the mid and hind tibiae,

(in *crassipes* and *brevicruralis* these setae are minute), by the mouth cone which is pointed (not broadly rounded), and by the wider pelta.

Although not yet found in Illinois, I have taken *salicarius* on willow in the nearby state of Arkansas at Rogers and there are specimens at the U.S. National Museum from Clarksville, Tennessee. Eventually this thrips may be found in our state also.

Lissothrips Hood

Lissothrips Hood (1908c:365). Type-species by monotypy.—*Lissothrips muscorum* Hood.

Head wider than long to longer than wide, surface smooth. Eyes moderate in size to relatively small. Ocelli present or absent. Postocular setae well developed, pointed to dilated. Cheeks smooth, without any strong bristles. Antennae eight segmented; segment III (Fig. 153) usually smaller than either segment II or segment IV, with no or one sense cone; segment IV with one inner and one or two outer sense cones; segment VIII varying from lanceolate to nonpedicellate and closely joined to segment VII. Mouth cone long, pointed. Maxillary stylets retracted far into the head, spaced moderately far apart within the center of the head. Maxillary bridge not discernible.

Thorax smooth. Prothorax with all major setae well developed, epimeral setae often especially long, these setae dilated to pointed. Epimeral sutures usually incomplete, occasionally complete. Praepectus present. Mesopraepectum degenerate. Meso- and metafurcae touching in apterous forms, separate in winged forms. Macropterous, brachypterous, or apterous. Fore wings when fully developed not indented in the middle, with or without accessory setae. Fore legs unarmed.

Pelta oval to nearly square, not subdivided into three parts, adjoined to the anterior margin of abdominal tergite II. Wing-holding setae not differentiated in apterous forms, differentiated in winged forms. Lateral abdominal setae usually long. Abdominal tergite IX with major posterior

setae often long, pointed in species in Illinois; lateral setae reduced in males. Abdominal sternite VIII with or without glandular area in males. Tube short to relatively moderate in length.

This genus is represented in Illinois by the single species *muscorum* which can be distinguished from all other species in our area with maxillary stylets placed well into the head proper by the small size of antennal segment III.

Other species occur in Florida, Texas, Mexico, the West Indies, Trinidad, Brazil, and possibly even in other parts of the world, according to the literature.

***Lissothrips muscorum* Hood**

Lissothrips muscorum Hood (1908c: 365). ♀. Type-locality.—Not stated, but holotype labeled Urbana, Illinois.

FEMALE (apterous).—Length distended about 1.4 mm. General color dark brown. Pedicel of antennal segment III and legs, especially the tarsi, lighter brown to nearly yellowish brown. Body with red subintegumental pigment. In life often with dark greenish internal fluids.

Head slightly wider than long, surface smooth. Eyes moderately small. Ocelli absent. Postocular setae long, dilated. Antenna as in Fig. 153; segment III small, without sense cones; segment IV longer with one inner and one outer sense cone; segment VIII slightly narrowed at base but broadly attached to segment VII. Mouth cone moderately long, pointed. Maxillary stylets retracted far into head, spaced moderately far apart within the head.

Prothorax smooth; major setae long and dilated, except epimeral setae which are pointed. Epimeral sutures incomplete to nearly complete. Wings entirely absent. Metanotum smooth, short, degenerate. Fore legs unarmed.

Pelta (Fig. 254) broadly oval. Wing-holding setae not differentiated. Abdominal tergite IX with major setae long, longer than tube, pointed. Tube moderate in size.

FEMALE (macropterous).—Length distended about 1.5 mm. Similar to



Fig. 254.—*Lissothrips muscorum*, pelta.

apterous female with following exceptions. Eyes larger. Ocelli present. Antennal segment III with one outer sense cone. Epimeral sutures incomplete. Epimeral setae much longer. Pterothorax well developed. Wings fully developed; fore wings light gray, without accessory fringe cilia. Pelta slightly smaller. Abdominal tergites III–VII each with one pair of sigmoidal wing-holding setae.

MALE (apterous).—Length distended about 1.1 mm. Similar to apterous female with the following exceptions. Epimeral sutures incomplete. Epimeral setae longer. Abdominal tergite IX with major lateral posterior setae greatly reduced in size. Abdominal sternite VIII apparently without a distinct glandular area.

By the reduced size of antennal segment III, this species is easily distinguished from other tubuliferous thrips in Illinois except *Phthirotithrips*, a genus easily recognized by short maxillary stylets that barely enter the head proper.

Lissothrips muscorum, as its name implies, inhabits mosses and occurs throughout the state in wooded areas.

Illinois records.—Collected every month of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, CALHOUN, CHAMPAIGN, CLARK, CUMBERLAND, DOUGLAS (Hood 1908c), HARDIN, JACKSON, JERSEY, LAKE, LA SALLE, MCHENRY, MONROE, PIATT, POPE, PULASKI, UNION, VERMILION, WASHINGTON (Hood 1908c), and WILLIAMSON (Hood 1908c).

Malacothrips Hinds

Malacothrips Hinds (1902:200).

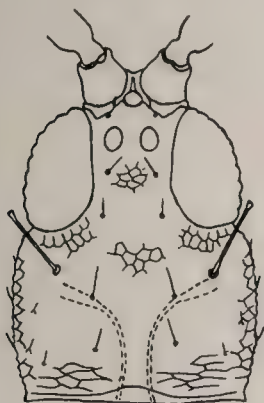
Type-species by monotypy.—

Malacothrips zonatus Hinds.

The following description applies principally to the fauna of Illinois.

Head (Figs. 255, 258, and 259) longer than wide, slightly prolonged forward of the eyes; surface weakly hexagonally reticulate; cheeks incised immediately behind the eyes. Eyes moderate in size, slightly bulged. Ocelli present, fore ocellus slightly pro-

longed. Postocular setae long, dilated. Antennae eight segmented, segment III similar in form to that found in some *Hoplandrothrips*, segments III and IV each with one inner and two outer sense cones, segment VIII pedicellate as in Fig. 256 (nonpedicellate



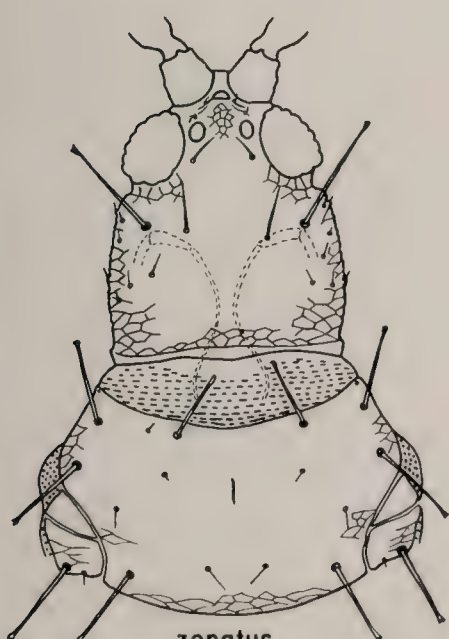
adranes
255



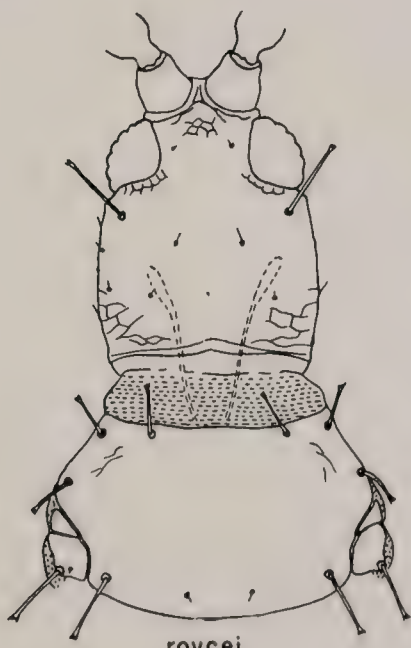
adranes
256



roycei
257



zonatus
258



roycei
259

Fig. 255-259.—Characteristics of species of *Malacothrips*: 255, head of *M. adranes*; 256, terminal antennal segments of *M. adranes*; 257, terminal antennal segments of *M. roycei*; 258, head and prothorax of *M. zonatus*; 259, head and prothorax of *M. roycei*.

in the eastern costal entity; *roycei* as in Fig. 257). Mouth cone pointed (broadly rounded in some species known out of state). Maxillary stylets retracted about halfway into the head, placed fairly close together within the head.

Prothorax smooth; all major setae well developed, dilated; with one pair of epimeral setae. Epimeral sutures complete. Praepectus absent. Metanotum only faintly sculptured. Macropterous or brachypterous. Fore wings when fully developed slightly indented in the middle, with accessory fringe cilia. Fore tarsi armed in both sexes.

Pelta triangular. Wing-holding setae moderately developed, slightly sigmoidal. Abdominal sternite VIII in males with a narrow transverse glandular area. Abdominal tergite IX in males with lateral posterior setae reduced in size. Tube moderate in size.

Although closely related to *Hoplandrothrips*, this genus superficially resembles *Eurythrips* on the basis of the notched cheeks and bulged eyes. *Malacothrips* in Illinois can be recognized by the characteristics of *zonatus*, the only species known to occur in our state.

***Malacothrips zonatus* Hinds**

Malacothrips zonatus Hinds (1902: 200). ♀. Type-locality.—Amherst, Massachusetts.

FEMALE (brachypterous) (Fig. 260).—Length distended about 2.7 mm. Bicolored brown and yellow. Brown: head, most of antennae except segment III and basal half of segment IV, posterior margin of pelta, most of abdominal segment II, lateral areas of abdominal segments VI and VII, most of abdominal segment VIII, and all of abdominal segments IX and X. Remainder of insect pale bright yellow. Body with red subintegumental pigment.

Head (Fig. 258) longer than wide, prolonged in front of eyes; surface weakly hexagonally reticulate; cheeks incised just behind eyes somewhat as in some species of *Eurythrips*. Eyes

large, slightly bulged. Ocelli present. Postocular setae long, dilated. Antennae eight segmented, segment III formed as in some species of *Hoplandrothrips* with one inner and two outer sense cones, segment IV with one inner and two outer sense cones, segment VIII strongly pedicellate. Mouth cone moderate in size, pointed. Maxillary stylets retracted halfway into the head, fairly closely spaced but not touching within the head.

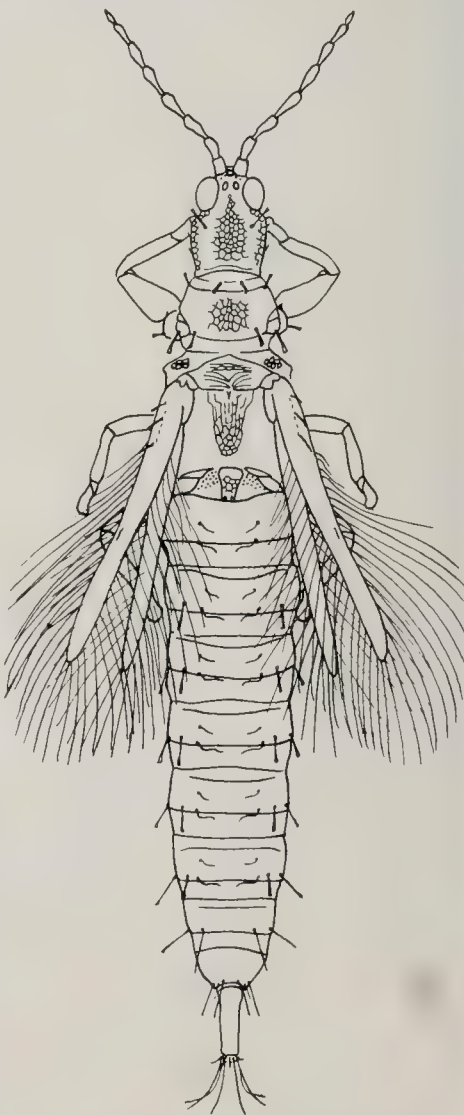


Fig. 260.—*Malacothrips zonatus*, dorsal aspect.

Prothorax smooth, with all major setae well developed and dilated. Metanotum only faintly sculptured. Wings reduced to pads. Fore tarsi each with a small tooth.

Pelta (Fig. 261) nearly triangular. Wing-holding setae moderately developed. Abdominal tergite IX with major posterior setae long, longer than tube, and pointed. Tube moderately long.

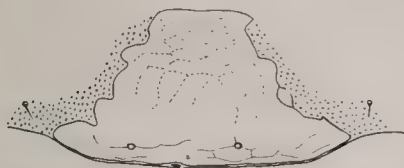


Fig. 261.—*Malacothrips zonatus*, pelta.

FEMALE (macropterous).—Length distended slightly less than 3 mm. Similar in color and structure to brachypterous female with the following exceptions. Wings fully developed, light gray except for a pale middle crossband. Fore wings slightly indented in the middle, each with six accessory fringe cilia.

MALE (brachypterous).—Length distended about 2 mm. Similar to brachypterous female with the following exceptions. Abdominal sternite VIII with a thin, transverse, linelike glandular area in the middle. Abdominal tergite IX with the lateral posterior setae greatly reduced in size.

This species can be distinguished from those assigned to *Eurythrips* by the absence of praepectal plates and from those assigned to *Hoplandrothrips* by coloration, the lack of strong reticulations on the metanotum, and by the incised outline of the cheeks just behind the eyes.

Apparently *zonatus* is statewide in distribution, occurring mostly in prairie grasses. It has an extensive range, being known at present from Massachusetts to eastern Kansas, western Iowa, and eastern North Dakota, and south at least to Arkansas.

Illinois records.—Found every month of the year, from one to several

localities in the following counties: ADAMS, ALEXANDER, CHAMPAIGN, CLAY, DOUGLAS, HANCOCK, IROQUOIS, JASPER, JERSEY, KNOX, LAKE, LEE, MASON, MCLEAN, MONROE, MONTGOMERY, PIATT, RICHLAND, SCOTT, and WILL.

Neothrips Hood

Neothrips Hood (1908c:371). Type-species by monotypy.—*Neothrips corticis* Hood.

Head longer than wide, prolonged in front of eyes, smooth. Eyes small, composed of a few large dorsal facets, in placement not extending beyond the cheek margins. Ocelli absent in brachypterous forms. Postocular setae well developed. Antennae eight segmented; segment III longer than IV; segments VII and VIII separated by a fine suture, but so closely joined as to form a pseudosegment. Mouth cone long and pointed. Maxillary stylets retracted far into the head, when retracted touching or nearly touching in the center of the head.

Prothorax long, slightly degenerate especially around margins where patches are broken into tiny platelets; smooth; all major setae well developed. Epimeral sutures complete. Praepectus absent. Mesopraesternum absent. Mesonotum fractured into stipple-like platelets anteriorly. Only brachypterous forms known. Legs short. Fore tarsi armed in both sexes.

Males without glandular area on abdominal sternite VIII. Abdominal tergite IX with major posterior setae long and pointed, of equal length in both sexes. Tube short and stout, fairly heavily sclerotized.

This genus resembles the *angusticeps* complex in *Hoplothrips*. It is not at all closely related to *Allothrips* or *Plectrothrips* as suggested by Hood (1908c), see Stannard (1957b). Its diagnostic characteristics, in the Illinois fauna, are those given under the species *corticis*. I have seen a new, second species in the private collections of Andre and of Post, from Wisconsin and North Dakota, respectively, taken from the bark of ash trees.

***Neothrips corticis* Hood**

Neothrips corticis Hood (1808c:372).
♀, ♂. Type-locality.—Not stated,
but holotype labeled Urbana,
Illinois.

FEMALE (brachypterous) (Fig. 262).
—Length distended nearly 2 mm.
General color yellowish brown to light
brown. Apexes of tibiae, all tarsi, and
pedicel of antennal segment III yel-
low. Tube orange-brown. Body setae
pale.

Head much longer than wide,
smooth. Eyes small, composed of
three or four large dorsal facets. Ocelli
absent. Postocular setae moderately
long, dilated. Antennal segment III
with no inner and one outer sense
cone; segment IV with one outer and
one inner sense cone; segment VIII
closely joined to segment VII, sepa-
rated only by a fine suture. Mouth
cone long and pointed. Maxillary sty-
lets retracted far into the head, nearly
touching in the middle of the head.

Prothorax with the margins ragged,
becoming degenerated into stipple-
like platelets; all major setae well de-
veloped, dilated. Epimeral sutures
complete. Praepectus absent. Meso-
praesternum absent. Metanotum
smooth. Wings reduced to small pads,
each of which has a single dilated seta.
Fore tarsi each armed with a small
tooth.

Pelta broadly triangular. Wing-
holding setae not differentiated. Ab-
dominal tergite IX with major poste-
rior setae slightly longer than tube,
pointed. Tube short and stout, fairly
heavily sclerotized.

FEMALE (macropterous).—Un-
known.

MALE (brachypterous).—Length
distended about 1.2 mm. Similar to
female in general color and structure.
Abdominal sternite VIII without a
glandular area. Abdominal tergite IX
with major lateral posterior setae not
reduced, exactly as in female.

This rare species is at once recog-
nizable in the fauna of Illinois by the
compact form of antennal segments
VII and VIII, the long and pointed
mouth cone, the placement of the
eyes, and the stout orange-brown tube.

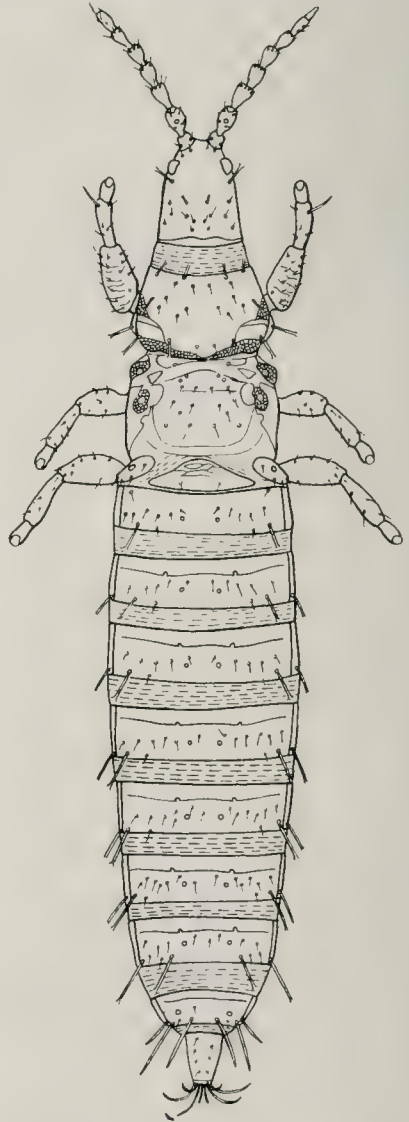


Fig. 262.—*Neothrips corticis*, dorsal aspect.

It is one of the few species in our area
belonging to the Phlaeothripinae
which, in the male, does not have the
major lateral posterior setae on ab-
dominal tergite IX reduced.

Although infrequently met with,
corticis has been taken throughout the
state from under bark of live or dead
branches.

Illinois records.—CHAMPAIGN
COUNTY: Urbana, January 19, 1908,
Hood, under soft maple bark, 1 ♂;

Urbana, March 13, 1949, Stannard, under soft maple bark, 1 ♀. KANKAKEE COUNTY: Bourbonnais (Rock Creek Canyon), May 13, 1950, Ross, Stannard, under cherry bark, 3 ♀, 1 ♂. PULASKI COUNTY: Mounds, August 16, 1951, Ross, Stannard, from dead beech branch, 1 ♀. VERMILION COUNTY: Hillery (Hood 1908c).

Neurothrips Hood

Neurothrips Hood (1924:315). Type-species by original designation.—*Acanthothrips magnafemoralis* Hinds.

Body with extensive hexagonal reticulations, generally intricately patterned with brown and yellow and colorless spots.

Head about as wide as long to longer than wide. Cheeks well expanded laterally with many seta-bearing warts. Eyes large, bean shaped, often about the width of an eye apart. Ocelli placed in a small triangle located midway between the anterior and posterior margins of the eye. Postocular setae placed on the median third of the head, small, thickened, dilated. Antennae eight segmented, intermediate antennal segments vasiform, sense cones fairly long. Mouth cone pointed. Maxillary stylets retracted far into the head, touching to nearly touching within the center of the head.

Thorax with major setae small, thickened, dilated. Prothorax with but one pair of well-developed epimeral setae. Epimeral sutures complete. Praepectus absent. Mesopraesternum well developed. Macropterous. Fore wings bent at base, narrowed beyond, without surface reticulations, with or without accessory fringe cilia. In species of Illinois, fore femora each with inner subapical tooth, fore tarsi each armed with a tooth.

Pelta often as in Fig. 264. Many abdominal tergites with expanded, leaf-like, wing-retaining setae (Fig. 1) placed near the meson and with thickened lateral posterior setae placed on projecting flanges of the tergites. Abdominal sternite VIII in males usually with a thin, transverse, median glandular area. Tube long and

slender (Fig. 186), terminal setae long, about four times the length of the tube.

This genus resembles *Acanthothrips* but differs primarily in the wide cheeks which extend much beyond the eye margin and in the broad, leaflike, wing-retaining setae on the abdomen.

Only one species, *magnafemoralis*, occurs in Illinois. It is one of the most spectacularly adorned and colored thrips in our state.

Neurothrips magnafemoralis (Hinds)

Acanthothrips magnafemoralis Hinds (1902:199). ♂. Type-locality.—Miami, Florida. Transferred to *Neurothrips* by Hood (1924).

FEMALE (macropterous).—Length distended over 3.2 mm. Color various shades of brown and yellow to nearly colorless in reflected light. Brown: head, most of thorax, most of abdominal segments I–VII, fore femora, apical half of mid and hind femora, median band on tibiae, antennal segments I and II, middle band of antennal segments III–V, and almost all of segments VII and VIII. Yellow to nearly colorless: antennal segments III–V in the basal and apical portions, all of segment VI and pedicel of segment VII, basal half of mid and hind femora, basal and apical portions of tibiae, all tarsi, all of abdominal segment VIII (which is yellow), and all of segment IX and basal one-third of tube (which are nearly colorless). Tube nearly black in apical two-thirds. Much of the brown area on the thorax and abdomen shading to yellowish brown, with occasional lateral spots becoming colorless. Fore wings generally colorless with a brown spot on leading margin at the region of the first basal fringe cilium and with a long, brown median streak. Setae colorless except bases of terminal setae which are brown. Body with red subintegumental pigment; red around region of ocelli.

Head as in Fig. 263, reticulate, slightly longer than wide, cheeks expanded with seta-bearing warts. Eyes large, bean shaped. Ocelli present. Postocular setae small, dilated, lo-

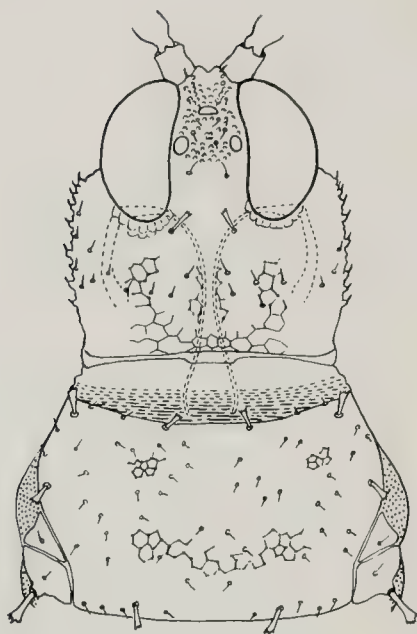


Fig. 263.—*Neurothrips magnafemoralis*, head and prothorax.

cated on the median third of the head. Antennal segments III–V vasiform, segments III and IV each with one inner and two outer sense cones subapically (segment IV with an additional small outer apical sense cone), segment VIII broadly attached to segment VII. Mouth cone pointed. Maxillary stylets retracted far into the head, touching to nearly touching within the center of the head.

Thorax reticulate. Prothorax (Fig. 263) with all major setae developed but small, dilated. Epimeral sutures complete. Fore wings without accessory fringe cilia. Fore femora each with a strongly developed inner subapical tooth, fore tarsi each armed with a large tooth.

Abdomen reticulate. Pelta as in Fig. 264. Abdominal tergites II–VII each with three pairs of leaflike, wing-holding setae (Fig. 1) along the meson; tergite VIII without these setae. Abdominal tergite IX with major posterior setae short, blunt to dilated. Tube long, terminal setae extremely long, suggestive of the condition found in *Amphibolothrips* and its subgenera.

MALE (macropterous).—Length

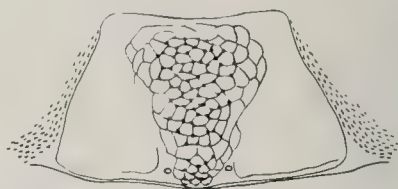


Fig. 264.—*Neurothrips magnafemoralis*, pelta.

distended about 2.6 mm. Similar to female in color and structure with the following exceptions. Fore tarsal teeth slightly smaller. Abdominal sternite VIII with a median, narrow, transverse glandular area, slightly upturned at each lateral end. Abdominal tergite IX with major lateral setae as in female, not reduced more than in female.

This distinctive, intricately colored species can be immediately distinguished from others in the Illinois fauna by the large, bean-shaped eyes, by the expanded head cheeks outlined by seta-bearing warts, and by the long terminal setae. In life *magnafemoralis* appears to be predominantly gray with a black tube that almost seems to be detached, so nearly colorless is abdominal segment IX.

Although found throughout the state, *magnafemoralis* is generally confined to large woodlands where it lives under bark, on branches, or in dead leaves.

Illinois records.—Collected from April to September (overwintering habits unknown), from one to several localities in the following counties: ADAMS, ALEXANDER, CALHOUN, CARROLL, CLARK, CLINTON, COOK, CRAWFORD, CUMBERLAND, DE WITT, EDGAR, FULTON, HARDIN, HENDERSON, HENRY, JACKSON, JASPER, JEFFERSON, JERSEY, JOHNSON, KANE, MACON, MARION, McDONOUGH, McLEAN, MONROE, OGLE, PEORIA, PULASKI, TAZEWELL, UNION, and VERMILION.

Phthirotithrips Priesner

Phthirotithrips Priesner (1933a:154).

Type-species by original designation.—*Phthirotithrips pediculus* Priesner.

Head about as long as broad, cheeks nearly straight, dorsal surface mostly

smooth. Ocelli absent in apterous forms, present in macropterous forms. Eyes relatively small, slightly bulged. Postocular setae usually well developed. Antennae seven or eight segmented; when eight segmented, segments VII and VIII closely joined but separated by a fine suture; segment I inserted just forward of eye margin; segment II with dorsal sensoria apically placed; segment III smallest, pedicellate, with or without sense cones. Mouth cone broadly rounded. Maxillary stylets when at rest hardly retracted into head proper.

Pronotum proportionately large, smooth; major anterior setae minute or well developed, posterior pairs the largest. Epimeral sutures incomplete. Praepectus seemingly present, though weakly developed. Macropterous or apterous. Fore wings when present not indented in middle, accessory fringe cilia lacking. Fore legs slightly to moderately enlarged, unarmed.

Abdomen broadest part of body. Pelta broad, smooth. All tergites smooth, with well-developed lateral setae, wing-holding setae not differentiated in apterous forms. Abdominal sternite VIII with glandular area in male. Abdominal tergite IX with major lateral posterior setae (setae II of authors) reduced and spinelike in male. Tube short; anal setae slightly longer than tube.

The characteristics of the extremely small size of antennal segment III, the complete fusion of antennal segments VII and VIII, and the short maxillary stylets that hardly enter into the head proper readily distinguish this genus in Illinois. Only one species, *morgani*, occurs in the southeastern part of the United States including southern Illinois; its congeners are from Brazil and Liberia (West Africa).

In this genus, several species including *morgani* apparently inhabit and feed on mosses. Similarly, *Lissothrips muscorum*, which also has a small third antennal segment, frequents mosses within the range of *Phthirotithrips*. Their separation for identification is based on the number of freely moveable antennal segments and placement of the maxillary stylets

well into or barely into the head proper; their ecological separation in the moss environment is not yet known.

Phthirotithrips morgani Hood

Phthirotithrips morgani Hood (1941: 206). ♀, ♂. Type-locality.—Gainesville, Florida.

FEMALE (apterous).—Length distended about 1 mm. Color medium brown, with dark green subintegumental pigment often in much of the abdomen. Apex of antennal segment II and pedicel of segment III yellow.

Head (Fig. 265) smooth. Eyes moderate in size, protruding slightly beyond cheeks. Ocelli absent. Postocular setae long, pointed. Antennae seven segmented; segment II with dorsal sensoria near apex; segment III smallest, pedicellate, without sense cones; segment IV with one inner and one outer sense cone; morphological segments VII and VIII completely fused without trace of suture between them. Mouth cone broadly rounded. Maxillary stylets barely penetrating into head proper.

Prothorax (Fig. 265) with major setae well developed, the posterior

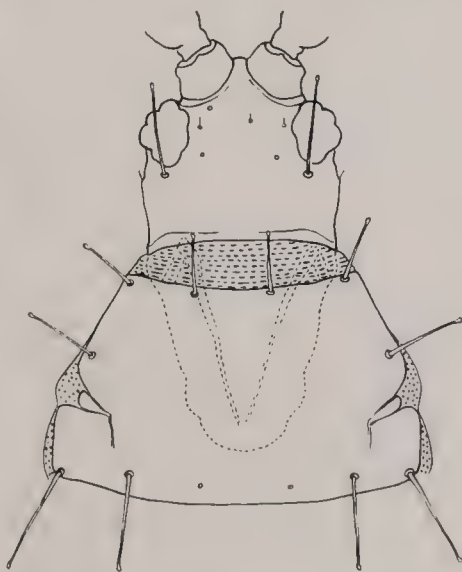


Fig. 265.—*Phthirotithrips morgani*, head and prothorax.

setae being the longest, all blunt. Epimeral sutures incomplete. Praepectus seemingly absent. Pterothorax degenerate, smooth. Fore legs slightly enlarged, unarmed. Wings and basal sclerites lacking.

Abdomen broadest part of body, devoid of sculpture. Pelta broad. Major lateral pairs of setae well developed, pointed. Wing-holding setae lacking. Abdominal tergite IX with major posterior setae longer than tube, pointed. Tube short; anal setae just slightly longer than tube.

MALE (apterous).—Length distended about 0.8 mm. Similar in color and structure to female with the following exceptions. Postocular setae minute. Prothorax with major setae shorter than in female. Fore legs moderately enlarged. Abdominal sternite VIII with a narrow, transverse glandular area across middle. Abdominal tergite IX with lateral pair of major, posterior setae shortened, spinelike.

This is the only species of the genus in the United States east of the 100th meridian, as far as is known, and therefore its recognition can be made in our fauna on the basis of the generic characteristics.

The types are in the U.S. National Museum. Other specimens from the type locality, and Chiefland, and Earlton, Florida are in the Watson collection, University of Florida, Gainesville. Hood's claim (1941) that *morgani* is "apparently a common enough species in the south" is possibly true although unsubstantiated by records in the literature. The two specimens from Florida mentioned by the protologist, the specimens from Florida in the Watson collection, and the Illinois specimen mentioned herein (and a single female from Whitewater Falls, Jackson County, North Carolina, collected from the fungus, *Polyporus pargamensis* Fr., June 26, 1962, by R. C. Graves, deposited in the Illinois Natural History Survey) are the only records yet made known in print.

Besides the manuscript name *Eulisothrips antennatus* circulated by A. C. Morgan, the manuscript name *Eulisothrips brevis* occurs on slides in the

Watson collection. Neither is a valid name and both apply to *P. morgani*.

Illinois records.—HARDIN COUNTY: Gibsonia (Pounds Hollow Recreation Area), April 25, 1963, Evers, Stannard, forest litter, 1 ♂.

Plectrothrips Hood

Plectrothrips Hood (1908c:370). Type-species by monotypy.—*Plectrothrips antennatus* Hood.

Head about as long as wide, smooth; fore margin nearly straight across and even with anterior portion of eyes. Ocelli present, widely spaced. Eyes moderately large. Postocular setae long. Antennae eight segmented, inserted ventrally beneath region of ocelli; segment II with dorsal sensorium placed basally; segment VIII long and slender. Antennal sense cones stout. Mouth cone short, rounded. Maxillary stylets, when at rest, retracted well into the head.

Pronotum reduced to a shield which is longitudinally divided by a ridge, with only epimeral setae well developed. Praepectus absent in Illinois species. Prosternum with many large stipple-like areas. Macropterous. Fore wings not indented in the middle, with accessory fringe cilia. Fore tarsi each armed with a stout tooth. Mid and hind tibiae with strongly developed apical spurs.

Pelta (Fig. 150) broad. Abdominal segment II degenerate at sides, stipple-like. Wing-holding setae differentiated. Males apparently without glandular area and without major lateral posterior setae of abdominal tergite IX shortened. Tube short, usually fairly heavily sclerotized, terminal setae long.

Larva, in the second instar at least, with abdominal tergite IX with four toothlike projections on posterior margin.

The distinctive form of the prothorax of this genus is diagnostic in the Illinois fauna. Only one species, *antennatus*, occurs in our state. Other representatives are found throughout the world.

Plectrothrips antennatus Hood

Plectrothrips antennatus Hood (1908c: 370). ♀, ♂. Type-locality.—Urbana, Illinois.

FEMALE (macropterous).—Length distended about 2.1 mm. Color dark brown in head, most antennal segments, thorax, and femora; light brown to brown in abdomen and base of antennal segment III; tibiae and tube yellow to yellowish brown; tarsi yellow. Wings nearly colorless. Body with red subintegumental pigment.

Head (Fig. 266) smooth. Eyes moderately large. Ocelli present. Postocular setae long, pointed, placed quite far behind eyes. Antennae eight segmented; segment II with dorsal sensorium placed basally; segment III fairly small with one inner and two outer, stout, sense cones; segment VIII long and slender. Mouth cone narrowly rounded. Maxillary stylets when retracted placed fairly close together within the head.

Prothorax (Fig. 266) with only

epimeral setae well developed, these pointed to nearly blunt. All other setae minute. Praepectus absent. Metanotum faintly longitudinally striate. Fore wings not narrowed in the middle, each with about eight accessory fringe cilia. Fore tibiae each with a small apical wart or tooth. Mid and hind tibiae with a pair of well-developed apical spurs. Fore tarsi each armed with a large tooth.

Pelta (Fig. 150) large. Abdominal segment II (Fig. 150) fractured laterally into tiny platelets. Wing-holding setae slightly sigmoidal. Abdominal tergite IX with major posterior setae shorter than tube, pointed. Tube short and fairly heavily sclerotized; terminal setae long.

MALE (macropterous).—Length distended about 1.4 mm. Similar to female in general color and structure. Abdominal sternite VIII apparently without glandular area. Abdominal tergite IX with major lateral posterior setae apparently not more reduced than in female.

The form of the pronotum is diagnostic in the Illinois fauna.

This rare species has been collected several times in Illinois. Some specimens have been associated with dead wood.

Illinois records.—CHAMPAIGN COUNTY: Urbana, June 23, 1908, Hood, on inside of woodshed window, 1 ♂ (paratype). FULTON COUNTY: Astoria, July 25, 1957, Stannard, dead branch, 1 ♀. JO DAVIESS COUNTY: Galena, June 21, 1948, Stannard, sweeping in forest, 1 ♀.

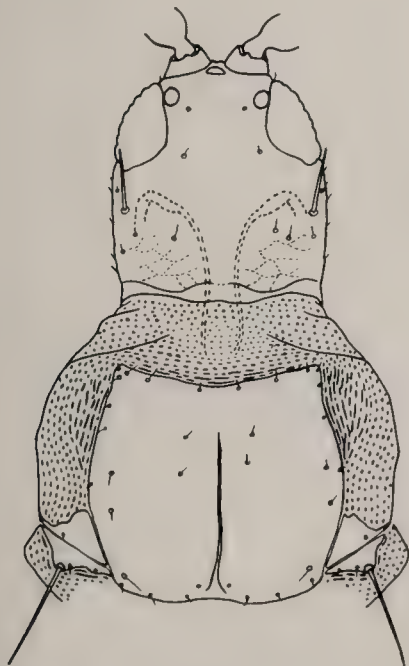


Fig. 266.—*Plectrothrips antennatus*, head and prothorax.

Poecilothrips Uzel

Poecilothrips Uzel (1895:264). Type-species by monotypy.—*Poecilothrips albopicta* Uzel.

Head longer than wide, weakly transversely striate, with many scattered, small, fine setae. Ocelli present in all forms, fore ocellus placed behind anterior eye margin. Eyes moderately large. Postocular setae minute. Antennae eight segmented, inserted at anterior eye margin and slightly ventrally; segment II with dorsal sen-

sorium placed about in the middle; segment VIII lanceolate. Mouth cone pointed, extremely long. Maxillary stylets slender, retracted far into the head, touching in the middle of the head.

Pronotum shorter than head, weakly sculptured, with all major setae well developed, stout, dilated; with only a single pair of epimeral setae. Epimeral sutures complete although weak. Praepectus absent. Mesosternum incised medially, surface fractured at this point into tiny platelets. Macropterous or brachypterous. Fore wings straight sided, accessory cilia present. Fore tarsi unarmed in both sexes.

Abdomen with pelta traingular. Abdominal tergites II-VII with differentiated wing-holding setae in all forms. Tube shorter than head with terminal setae only slightly longer than tube.

General color dark brown spotted with chalk white.

Superficially *Poecilothrips* resembles *Hoplandrothrips*. The lack of well-developed postocular setae and the degeneration of the middle of the anterior margin of the mesosternum are characteristics that, combined, serve to distinguish *Poecilothrips*.

Possibly this might be a monobasic genus containing only *albopictus*. Another presently remaining name associated with this genus, *harrisoni* Bagnall, is of uncertain status and might be a synonym of *albopictus* (Pelikán, 1950). Faure (1955) assigned his South African species, *nubilus*, to *Poecilothrips*, but that species differs in many ways from the European type, and, reasonably, could be separated to a subgenus or full genus of its own.

Poecilothrips albopictus Uzel

Poecilothrips albopicta Uzel (1895: 264). ♀. Type-locality.—Bohemia (Czechoslovakia). Pelikán (1950). ♂.

Phloeothrips ornatus Hood (1913b: 165). ♀. Type-locality.—Washington, D. C. Transferred to *Poecilothrips* by Hood (1927c). Synonymized by Pelikán (1950).

Poecilothrips lupini Moulton (1929c: 133). ♀. Type-locality.—Mountain View, California. Suggested as synonym by Bailey (1949b).

FEMALE (macropterous).—Length distended about 2.4 mm. General color dark brown, marked with white on the posterior angles of the prothorax and on the lateral angles of abdominal tergites I-VIII. Variations of the white color pattern have been illustrated by Pelikán (1950). Antennal segments I and II dark brown; segments III-VI brown apically, pale yellow basally; segments VII and VIII brown. Legs brown except tibiae, at either end, and all tarsi yellowish brown. Fore wings pale, lightly clouded with gray at the base and in the middle. Subintegumental pigment bright red. Major body setae pale.

Head (Fig. 267) longer than wide; dorsal surface weakly striate; bearing many small, fine setae; interocellar area longitudinally striate. Eyes large, each longer than combined lengths of antennal segments I and II, and placed fairly close together. Ocellar area closely confined between eyes, fore ocellus placed posterior to anterior eye margin. Postocular setae minute. Maxillary stylets, when at rest, retracted to a position forward of posterior eye margin, touching within center of head. Mouth cone pointed, extremely long, extending posteriorly beyond the prothorax.

Antennal segment I quadrate; II cylindrical, pedicellate, dorsal sensorium placed in about the middle; III-V subvasiform, III with one inner and one outer sense cone, IV with two inner and two outer sense cones; VI cylindrical, narrowly pedicellate; VII cylindrical, more broadly pedicellate; VIII lanceolate, broadly pedicellate.

Prothorax shorter than head, weakly sculptured, with all major setae well developed, stout, dilated. Epimeral sutures complete. Praepectus absent.

Pterothorax widest part of body. Metascutum with closely spaced longitudinal striations.

Legs slender, unarmed.

Fore wings more or less straight

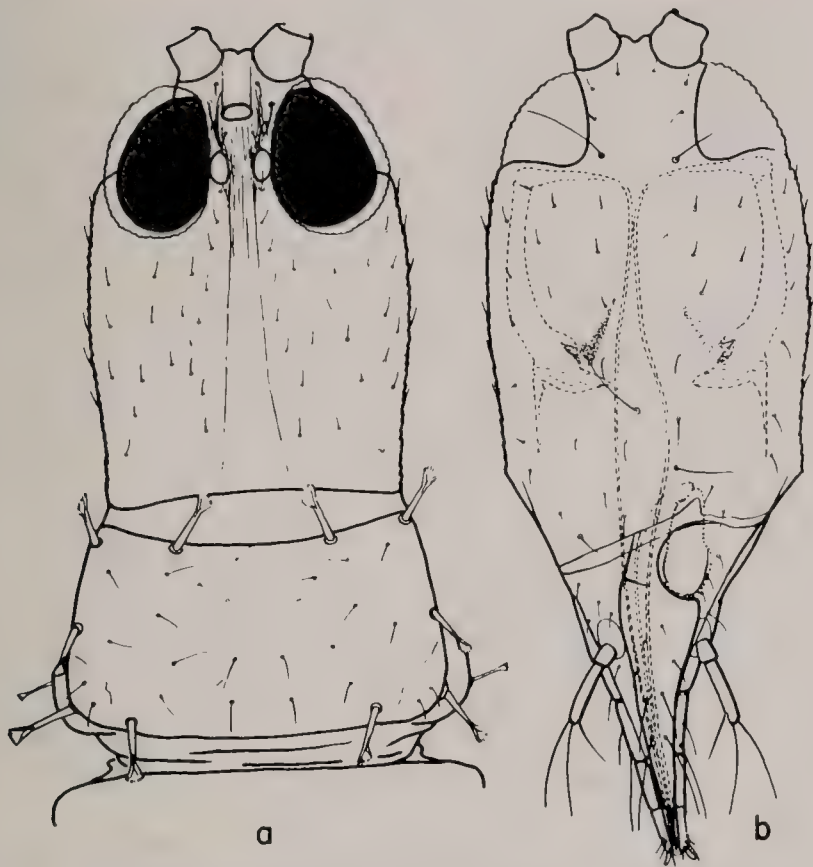


Fig. 267.—*Poecilothrips albipictus* from Europe and east and west coasts of the U.S.A.: a, head and thorax, dorsal aspect; b, head, ventral aspect. From Pelikán (1950).

sided, each with 12 accessory fringe cilia; major three basal setae dilated.

Abdominal tergite I with pelta triangular (Fig. 268). Abdominal tergites II–VII each with two pairs of wing-holding setae, the anterior pair weak, the posterior pair strongly developed, sigmoidal; lateral setae dilated. Abdominal tergite IX with posterior setae shorter than tube, dilated. Abdominal segment X (tube) much shorter than head, terminal setae slightly longer than tube.

FEMALE (brachypterous).—Similar in all respects to macropterous form except wings reduced to small pads, and both pairs of wing-holding setae on abdominal tergites II–VII greatly reduced.

MALE (macropterous).—Described by Pelikán (1950). Legs unarmed.

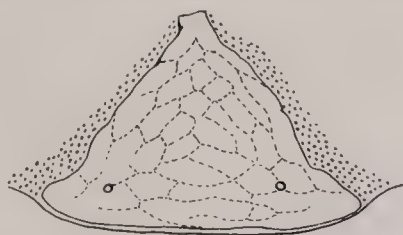


Fig. 268.—*Poecilothrips albipictus*, pelta.

Presence or absence of abdominal sternal glandular areas not mentioned in description. This sex known only in Europe.

According to Bailey (1931) and Pelikán (1950) *albopictus* lives in colonies, adults and larvae together, on the surface of dead or dying bark, particularly smooth oak or willow

bark. Presumably there are several generations a year.

This distinctive, white-dotted species probably came to America through the agency of modern man. It occurs in New York state as far west as Rochester and in Pennsylvania, New Jersey, Washington, D. C., and also in Washington and California (Cott 1956). Despite much searching, it has not been found in Illinois, but its presence in our state is likely.

Polyphemothrips Schmutz

Polyphemothrips Schmutz (1909a: 276). Type-species by monotypy.—*Pholypthemothrips braziliensis* Schmutz.

Members of this genus are principally found in the tropics, particularly Central and South America. Only one group of *Polyphemothrips*, the subgenus *Adelothrips*, has representatives occurring as far north as Illinois.

In general, species of the typical subgenus *Polyphemothrips* are moderately large in size, have decidedly swollen cheek pouches, and have the fore ocellus overhanging the bases of the antennae. In other respects, they are similar to those placed in the subgenus *Adelothrips* whose characteristics are described herein.

Polyphemothrips, its subgenera, and allied genera are peculiar in that the maxillary stylets are thicker than those ordinarily found in the Phlaeothripinae. These closely related genera can be placed together in the *Docessis-sophothrips* phyletic line (Stannard 1957b).

Subgenus *Adelothrips* Hood

Adelothrips Hood (1938c:380). Type-species by original designation.—*Adelothrips xanthopus* Hood.

The following description pertains solely to the fauna of Illinois.

Head longer than wide, somewhat arched on the dorsum of the posterior region of the head so that the faint reticulations appear to be upturned in slide-mounted specimens, cheek pouches absent. Eyes moderate in size

to small. Ocelli well developed in macropterous forms, somewhat reduced or absent in brachypterous forms, not overhanging insertions of antennae. Postocular setae fairly long, dilated or pointed. Antennae seven or eight segmented, the division between morphological segments VII and VIII either complete with a fine suture (Fig. 154) or incomplete with a partial ventral suture. Antennal sense cones usually long and slender. Mouth cone broadly rounded to nearly pointed. Maxillary palps large. Maxillary stylets thicker than usual for most other members of the Phlaeothripinae, retracted far into the head, nearly touching in the center of the head when fully retracted.

Prothorax with all major setae well developed. Epimeral sutures complete. Praepectus absent. Mesopraesternum usually well developed in macropterous forms, degenerate in brachypterous forms. Metanotum usually smooth. Macropterous or brachypterous. Fore wings when fully developed not indented in the middle, with or possibly without accessory fringe cilia. Fore tarsi each armed, in both sexes, with a strong tooth.

Pelta usually triangular. Wing-holding setae well developed in macropterous forms, less developed in brachypterous forms. Males apparently without glandular areas on abdominal sternite VIII, with major lateral posterior setae on abdominal tergite IX greatly reduced. Females with major posterior setae on abdominal tergite long and pointed. Tube shorter than head, often colored with shades of orange or yellow and tipped with grayish brown.

In Illinois this genus can be easily recognized by the slightly thickened maxillary stylets, the close union of morphological segments VII and VIII of the antennae, the large maxillary palps, and the upturned reticulations (sometimes faint) on the posterior portion of the dorsum of the head.

Recognition of *Adelothrips* as an entity rather than as an outright synonym of *Polyphemothrips* was made here to conform to custom and because *Adelothrips*, while not absolute-

ly separable from *Polyphemothrips*, is a category of some usefulness, especially in our region. At least, *Adelothrips* stands for a certain section of species in *Polyphemothrips*, and in areas where there are no intergrading species the designation of that section can be made without the possibility of confusion.

Four species occur in Illinois. Presumably all live on fungus spores and are found in forest ground cover or on dead branches.

KEY TO SPECIES

- 1. Mouth cone pointed to nearly pointed because maxillary palps protrude posteriorly; antennal segments VII and VIII nearly to completely divided by a fine suture **ambitus**
Mouth cone broadly rounded (Fig. 197), maxillary palps not protruded to any great extent posteriorly; antennal segments VII and VIII only partially divided 2
- 2. Color predominantly yellow; in forest debris **bratleyi**
Color predominantly brown; on dead branches 3
- 3. Postocular setae pointed; base of tube usually orange-brown **acutus**
Postocular setae dilated; base of tube always dark brown **junctus**

Polyphemothrips (Adelothrips)
acutus (Stannard)

Adelothrips acutus Stannard (1956c: 108). ♀, ♂. Type-locality.—Mapleton, Illinois. Transferred to *Polyphemothrips* by Stannard (1957b).

FEMALE (brachypterous).—Length distended 2.8–3 mm. General color dark brown. Antennal segments I and II, pedicel of segment III, and all tarsi yellowish brown. Tube orange-yellow to orange-brown, tipped with grayish brown. Body with red subintegumental pigment.

Head (Fig. 271) longer than wide. Eyes somewhat reduced in size. Ocelli present. Postocular setae long and pointed. Antennal segment III with one inner and two outer sense cones, segment IV with two inner and two outer sense cones, segments VII and VIII fused although with an incomplete ventral suture. Mouth cone

broadly rounded, labial palps not protruding posteriorly.

Prothorax with all major setae well developed, usually blunt or slightly dilated. Epimeral sutures complete. Mesospinasternum degenerate, almost entirely reduced or absent. Metanotum smooth. Wings reduced to small pads. Fore tarsi each armed with a strong tooth.

Pelta triangular. Wing-holding setae weakly developed. Abdominal tergite IX with major posterior setae long and pointed. Tube slightly more than one-half as long as head.

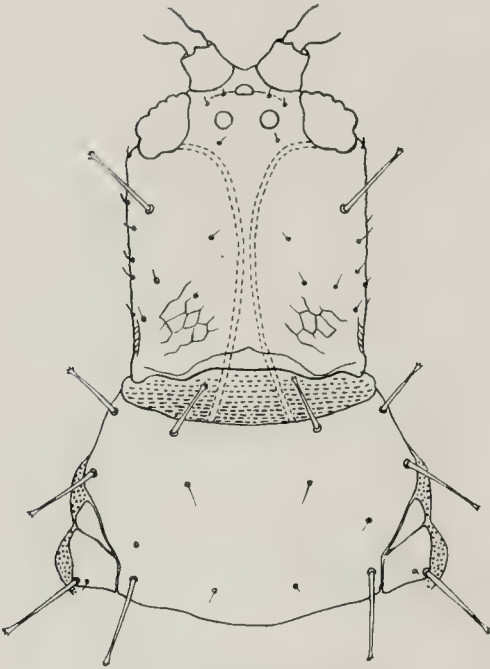
FEMALE (macropterous).—Length distended slightly less than 3 mm. Similar to brachypterous female in general structure and color with the following differences. Eyes slightly larger. Fore wings fully developed, lightly washed with brown, each with about six accessory fringe cilia. Wing-holding setae more fully developed, although not as large as in *ambitus*.

MALE (brachypterous).—Length distended about 2 mm. Similar to brachypterous female in general color and structure. Major form (the only form so far known) with fore legs slightly enlarged, fore tarsal tooth stouter than in female, prothorax (Fig. 273) with a median longitudinal ridge. Abdominal sternite VIII without a glandular area. Abdominal tergite IX with major lateral posterior setae greatly reduced in size.

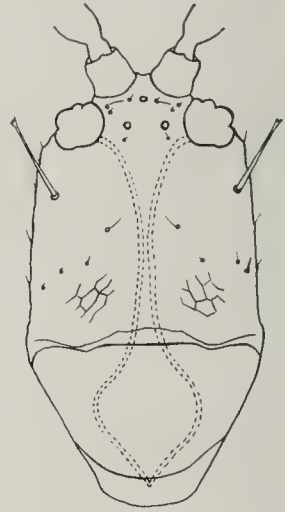
This species is extremely close to *junctus* and could be, in fact, only a form of *junctus*. From *junctus*, *acutus* may be distinguished by the postocular setae which are pointed at the tip, not dilated as in *junctus*, and usually by the color of the tube which is predominantly orange-yellow to orange-brown, not brown as in *junctus*.

So far this species has been found in only a few localities in Illinois. Its range lies within the range of *junctus*.

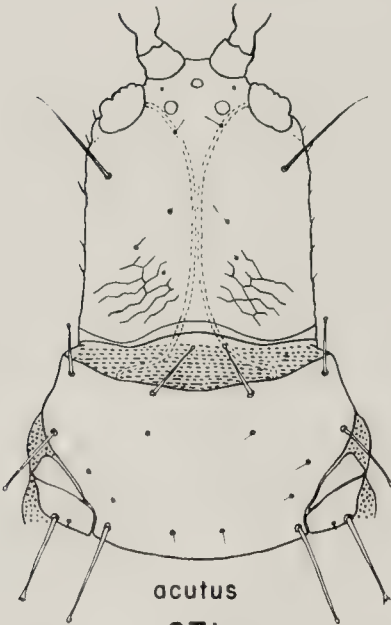
Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 8, 1951, Richards, Stannard, on willow, 2 ♀. CUMBERLAND COUNTY: Toledo, May 18, 1950, Sanderson, Stannard, beating dead elm branch, 1 ♀. FULTON COUNTY: Anderson Lake Conservation Area, September 8, 1954, Ross,



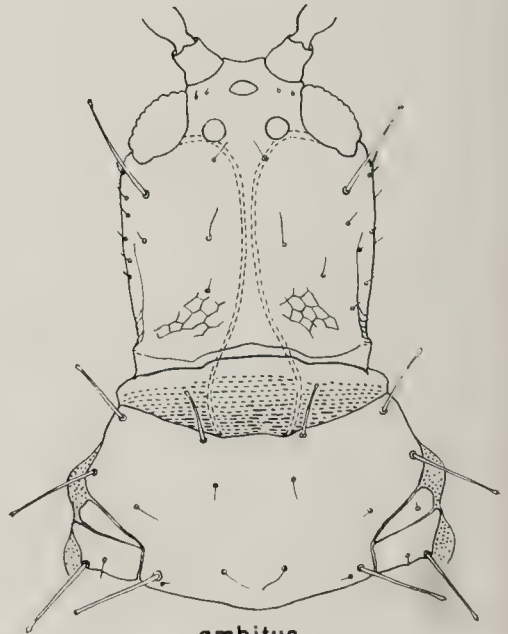
bratleyi, macropterous
269



bratleyi, brachypterous
270



acutus
271



ambitus
272

Fig. 269-272. Head and prothorax of species of *Polyphemothrips* subgenus *Adelothrips* as indicated.

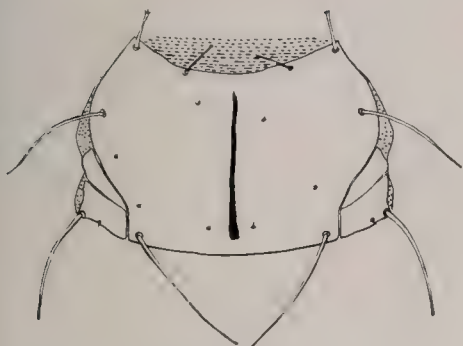


Fig. 273.—*Polyphemothrips* (*Adelothrips*) *acutus*, ♂, prothorax.

Stannard, on dead willow, 1 ♀, 3 ♂.
GALLATIN COUNTY: Gibsonia (Pounds Hollow Recreation Area), April 24, 1963, Stannard, dead branch, 1 ♀.
JACKSON COUNTY: Giant City State Park, April 28, 1949, Sanderson, Stannard, beating dead *Crataegus*, 1 ♀.
PEORIA COUNTY: Mapleton, June 2, 1949, Stannard, from dead willow branch, 1 ♀.

***Polyphemothrips* (*Adelothrips*) *ambitus* (Hinds)**

Trichothrips ambitus Hinds (1902: 191). ♀. Type-locality.—Amherst, Massachusetts. Hood (1914b). ♀. Transferred to *Polyphemothrips* by Stannard (1957b).

FEMALE (macropterous) (Fig. 274).—Length distended about 3.4 mm. General color yellow with brown areas ranging from individuals which are largely yellow to individuals which have extensive areas of brown. Brown: always anterior portion of head; terminal segments of antennae (apical half of antennal segment IV, apical three-fourths of V, and all of VI–VIII); occasionally prothorax (although in most specimens prothorax yellow); always mesothorax; sometimes anterior portions of metathorax; mid and hind femora; fore wings at extreme base and an area basal of the middle; sometimes sides of abdominal segments II–VI, always sides of abdominal segments VII and VIII, and tip of tube. Remainder of body

yellow except tibiae and tarsi of the mid and hind legs and at least the apical half of the fore wings, which are nearly colorless. Tube in basal four-fifths yellowish orange to orange to orange-brown, being darkest in those individuals with the prothorax brown. Body with red subintegumental pigment.

Head (Fig. 272) longer than wide, widest just behind eyes. Eyes moderate in size. Ocelli present. Postocular setae fairly long and slightly dilated. Antennal segment III with one inner and two outer sense cones, segment IV with two inner and two outer sense cones; segments VII and VIII (Fig. 165) forming a compact mass completely divided, or nearly so, by a thin suture. Mouth cone bluntly rounded but appearing nearly pointed because the labial palps are protruded posteriorly.

Prothorax with all major setae well developed, dilated. Epimeral sutures complete. Mesospinasternum well developed. Fore wings not indented in the middle, each with 10–12 accessory fringe cilia. Fore tarsi each armed with a strongly developed tooth.

Pelta triangular (Fig. 171). Wing-holding setae well developed, sigmoidal. Abdominal tergite IX with major posterior setae long and pointed (a specimen in our collection from Rock, Pope County, Illinois has one of the mid pair of these setae blunt; the other is normal and pointed). Tube shorter than head length.

MALE (macropterous).—Length distended about 2.9 mm. Similar in general color and structure to female. Abdominal sternite VIII without a distinct glandular area. Abdominal tergite IX with major lateral setae greatly reduced in size.

This species resembles the Floridian *xanthopus* in color and structure. It differs from *xanthopus*, and from its congeners in Illinois as well, by the position of the labial palps. In *ambitus*, the labial palps protrude posteriorly completely beyond the mouth cone proper, making the mouth cone appear to be pointed. As in the Brazilian species, *palmarum* Hood, *ambitus* has

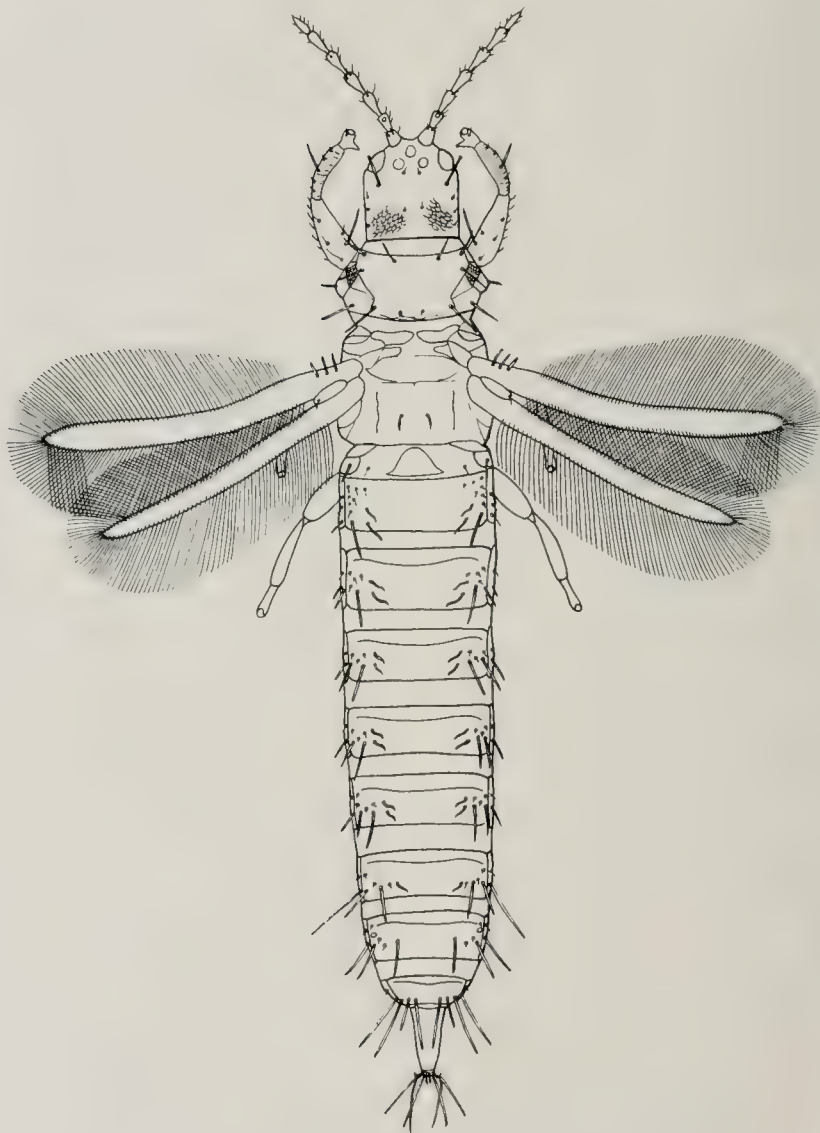


Fig. 274.—*Polyphemothrips (Adelothrips) ambitus*, dorsal aspect.

antennal segments VII and VIII completely separated.

Although nowhere known to be common, *ambitus* occurs throughout our state. We have taken it from under bark of dead branches, particularly of sycamore, locust, and willow.

Illinois records.—ADAMS COUNTY: Siloam Springs State Park, August 9, 1951, Richards, Stannard, dead willow, 1 ♀, 1 ♂. CALHOUN COUNTY: Beecreek, August 10, 1951, Richards,

Stannard, dead branch, 1 ♀. COOK COUNTY: Des Plaines, April 17, 1954, Graves, on fungus, 1 ♀. DE KALB COUNTY: Sycamore, September 15, 1955, Ross, Stannard, dead willow, 1 ♀. HARDIN COUNTY: Cave-in-Rock, May 2, 1956, Stannard, dead locust tree, 1 ♀. JACKSON COUNTY: Makanda, July 14, 1948, Sanderson, Stannard, sycamore branch, 1 ♀. LAKE COUNTY: Antioch, August 31, 1955, Moore, Stannard, dead branch, 1 ♀.

POPE COUNTY: Rock, May 6, 1950, Sanderson, Stannard, beating dead willow, 1 ♀. UNION COUNTY: Alto Pass, May 10, 1951, Sanderson, Stannard, dead apple branch, 1 ♀, 1 ♂; Jonesboro, August 15, 1951, Ross, Stannard, dead branch, 1 ♀. VERMILION COUNTY: Danville, October 17, 1950, Ross, Stannard, beating sycamore branch, 1 ♀.

**Polyphemothrips (Adelothrips)
bratleyi (Watson)**

Trichothrips bratleyi Watson (1935: 61; 1937b:12). ♀, ♂. Type-locality.—Quincy, Florida, see explanation below. Transferred to *Polyphemothrips* by Stannard (1957b).

Hoplothrips flavus Moulton and Andre (1936:225). ♀, ♂. Type-locality.—Ottumwa, Iowa. Synonymized by Hood (1952a).

FEMALE (brachypterous) (Fig. 275).—Length distended about 2.5 mm. General body color yellow. Antennal segment IV at apex, segment V in apical half, segment VI in apical two-thirds, and all of segments VII and VIII brown. Tube deep orange at base fading to yellow, tip grayish brown. Body with red subintegumental pigment.

Head (Fig. 270) long, about $1\frac{1}{3}$ times as long as wide. Eyes small, reduced to about a half dozen fairly large facets. Ocelli present but reduced in size. Postocular setae well developed, dilated. Antennal segment III with one inner and two outer sense cones, segment IV with two inner and two outer sense cones, segments VII and VIII (Fig. 163) fused except for a partial ventral suture that is occasionally reduced to a dot. Mouth cone broadly rounded, labial palps not protruding posteriorly.

Prothorax with all major setae well developed, dilated; anteromarginal setae smaller than the anterolateral pair, the anterolateral setae nearly equal to the midlateral pair. Epimeral sutures complete. Mesospinasternum somewhat degenerate. Metanotum smooth, not reticulate. Wings reduced

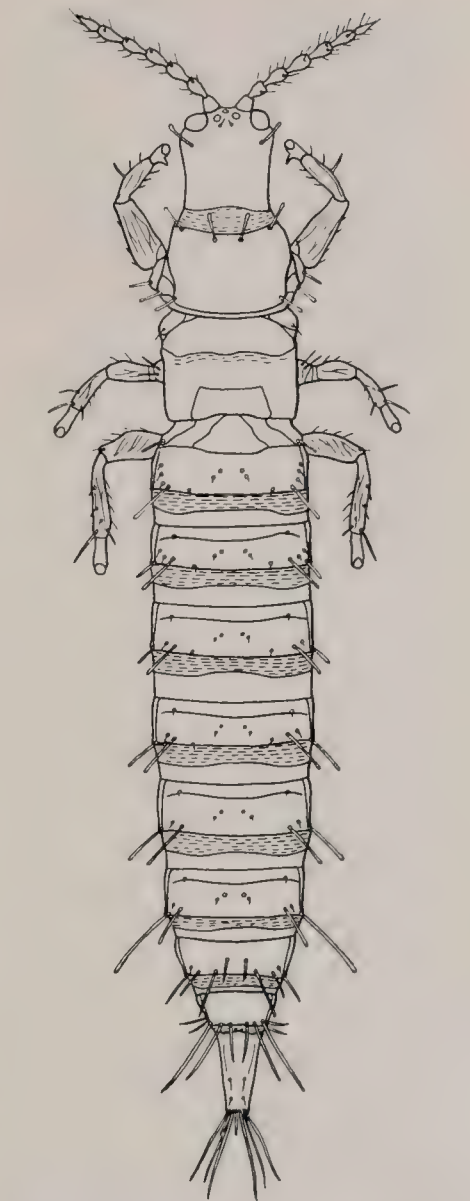


Fig. 275.—*Polyphemothrips (Adelothrips) bratleyi*, ♀ brachypterous, dorsal aspect.

to small pads. Fore tarsi each armed with a strong tooth.

Pelta roughly triangular to trapezoid. Wing-holding setae weakly developed. Abdominal tergite IX with major posterior setae long and pointed. Tube two-thirds as long as head.

FEMALE (macropterous).—Length distended over 2.5 mm. Similar to

brachypterous female except for the following modifications. Eyes (Fig. 269) larger with many more dorsal facets, which anteriorly are smaller than those in the brachypterous form. Ocelli larger. Wings fully developed, seemingly without accessory fringe cilia. Wing-holding setae well developed.

MALE (brachypterous).—Length distended about 1.6 mm (minor form) to 2.2 mm (major form). Similar to brachypterous female in general color and structure with the following exceptions. Ocelli slightly reduced (major forms) to sometimes absent (minor forms). In major forms fore legs enlarged and prothorax with a median longitudinal ridge. Abdominal sternite VIII without a glandular area. Abdominal tergite IX with major lateral setae greatly reduced in size.

MALE (macropterous).—Unknown.

In Illinois, *bratleyi* is the only species which is primarily yellow in color and is frequently brachypterous.

Throughout the southeastern part of the United States this species is locally abundant in woodland leaf mold, although occasionally it has been taken in *Andropogon* clumps near forest edges.

Both major and minor forms occur in the two sexes with the greatest enlargements of parts in the major male. The major form exhibits a thicker and blunter fore tarsal tooth, a more swollen fore femur, and a larger prothorax with a median thickened longitudinal ridge as in Fig. 273. This ridge is absent or only faintly present in minor individuals.

Of the three dozen or so specimens that I have studied, only one out-of-the-ordinary variation of the characteristics listed here was noted. That one exception occurred in a brachypterous female from Illinois which had the dorsal median pair of posterior setae of abdominal tergite IX dilated at the tip instead of having the usual pointed condition; yet in all other characteristics this specimen was conspecific. The dilation of similar setae was found to be one of several specific characteristics for the Brazilian *palmarum* (Hood 1952a).

Watson's original description of *bratleyi* was continued over several years. The first part, the description of the female, appeared in 1935, and while it was not complete according to the general pattern of descriptions followed by most taxonomists I have accepted Watson's name as the valid one. In 1937 Watson finished the description started in 1935. He described the male, gave locality data for the two sexes, and finally compared the species to an allied species. Meanwhile Moulton and Andre (1936) named this species *Hoplothrips flavus*. I think Moulton and Andre hold the unusual record of having published the description of a species "between" the publication of another name for the same species by another author. From the literature no one could have surmised that the two names stood for the same species.

Actually Watson's description is quite different from the foregoing. In stating the color, in declaring that antennal segments VII and VIII were completely separated by a suture, and in calling the supposed brachypterous specimen an apterous individual, he was seemingly inaccurate. The lectotype selected here is the brachypterous female on the slide in the Watson collection labeled "Type ♀, Quincy, Fla., Oct. 16, 1930, Watson & Bradley, fr. dead Spanish moss, on ground in hammock." Other slides in this collection also marked "type" contain males.

Illinois records.—Collected every month of the year in the eastern United States and from one to several localities in the following Illinois counties: ADAMS, ALEXANDER, CLAY, COLES, CUMBERLAND, LAKE, LAWRENCE, MONTGOMERY, POPE, PULASKI, WASHINGTON, and WHITE.

Polyphemothrips (Adelothrips) junctus (Hood)

Cryptothrips junctus Hood (1912c: 139). ♀, ♂. Type-locality.—Baldwin, Michigan. Transferred to *Adelothrips* by Hood (1952a). Transferred to *Polyphemothrips* by Stannard (1957b).

Hoplothrips quercus Moulton and Andre (1936:225). ♀, ♂. Type-locality.—Boone, Iowa. Synonymized by Hood (1952a).

FEMALE (brachypterous, major form).—Length fully distended nearly 3 mm. General color dark brown, being lighter on the dorsum of the median abdominal segments. Antennal segment III in pedicel and tarsi yellowish brown. Setae, except anal setae, yellow. Body with much red subintegumental pigment.

Head longer than wide, slightly bulged at angles of eyes. Eyes somewhat reduced in size, entirely on the anterior border of the head. All ocelli present, somewhat reduced in size. Postocular setae well developed, dilated at tips. Antennal segment III with one inner and two outer sense cones, segment IV with two inner and two outer sense cones, segments VII and VIII fused although with a partial ventral suture. Mouth cone (Fig. 197) broadly rounded.

Prothorax shorter than head, with all major setae dilated. Mesospinasterum degenerate. Metanotum smooth. Wings reduced to small pads. Fore legs not as enlarged as in major males. Teeth well developed but slender.

Pelta broadly triangular. Wing-holding setae weakly developed. Abdominal tergite IX with major terminal setae nearly equal to length of tube, pointed. Tube slightly more than one-half as long as head, anal setae longer than tube.

FEMALE (macropterous).—Similar to brachypterous female except wings fully developed, uniformly brown, and with five or six accessory fringe cilia on each fore wing. Tube and antennal segments I and II brown. Postocular setae dilated, as in brachypterous form.

MALE (brachypterous, major form).—Length distended over 2 mm. Similar to female in general color and structure. Ocelli reduced in size, sometimes fore ocellus absent. Prothorax with a median longitudinal ridge. Fore legs enlarged, fore tarsi (Fig. 276) each armed with a strong, stout tooth. Abdominal sternite VIII without a glan-



Fig. 276.—Fore tarsus of *Polyphemothrips* (*Adelothrips*) *junctus*, ♂, showing tooth-like projection.

dular area. Abdominal tergite IX with median pair of major posterior setae long and pointed, lateral pair greatly reduced in size.

The darker color of the antennae and the dilated postocular setae distinguish *junctus* from *acutus*, although in other respects the two are similar. As yet neither *junctus* nor *acutus* have been collected in sufficient numbers to permit any conclusions on the possible range of variability. Perhaps *pericles* (Hood) is also conspecific.

According to Hood (1912c), pupae occur under loose scales of bark in August and by the end of August adults appear, with males emerging earlier than females. It is not known whether there is more than one generation a year.

Illinois records.—CHAMPAIGN COUNTY: Mahomet, April 17, 1908, Ewing, under bark, 1 ♀, (Hood 1912c). CLARK COUNTY: Clarksville (Rocky Branch), July 2, 1958, Ross, Stannard, dead branch, 1 ♂. JACKSON COUNTY: Murphysboro (Hood 1912c). OGLE COUNTY: Oregon, September 27, 1956, Ross, Stannard, dead branch, 1 ♀.

Preeriella Hood

Preeriella Hood (1939a:612). Type-species by original designation.

Chirothripoides minutus Watson.

Body cylindrical, not dorso-ventrally compressed.

Head longer than wide, surface smooth except for a few transverse striae at base of head. Ocelli present. Postocular ? setae (affinities not certain) long and dilated to blunt. Antennae (Fig. 160) inserted in front of eyes on slight, forward protrusion of head; seven or eight segmented; morphological segment III cup shaped, broadly attached to segment IV or completely fused to IV as in one South American species. Mouth cone (Fig. 195) broadly rounded. Maxillary stylets when at rest retracted well into the head.

Prothorax smooth, with a median transverse ridge. Anterolateral and major posterior setae well developed, anteromarginal setae closely placed near anterolateral setae and moderately short to small, midlateral setae minute. Epimeral sutures incomplete. Praepectus not discernible. Probasi-sternal plates seemingly very large. Metanotum with a few median striations. Meso- and metasternum with a continuous longitudinal ridge connecting the furcae. Macropterous, wings extremely narrow, fore wings with cilia widely spaced, without accessory fringe cilia. All tarsi apparently one segmented.

Pelta (in the type-species at least) divided into three parts. Wing-holding setae well developed, sigmoidal in shape. Males seemingly without glandular areas, major lateral setae on the posterior margin of abdominal tergite IX not reduced more than in female. Tube short, slender in some species, stout in others.

Body setae pointed, blunt, or moderately dilated.

This genus is represented in our state by the type-species, *minuta*, which is the smallest tubuliferan in our fauna.

Preeriella most closely resembles *Hydiiothrips*, a neotropical genus that does not occur north of Mexico and southern Florida as far as is known.

The diagnostic characteristics of *minuta* should suffice for the recognition of the genus in the biota of Illinois.

Preeriella minuta (Watson)

Chirothripoides minutus Watson (1937b:13). ♂. Type-locality.—Gainesville, Florida.

FEMALE (macropterous).—Length distended slightly less than 1 mm. General color pale yellow with light brown markings. Light brown: head in region of ocelli; antennal segments IV–VIII, being lightest brown in segment IV; a transverse middle band across the prothorax especially at the sides; anterior angles of pterothorax; and basal region of the fore wings. Ocellar pigment red.

Head (Fig. 277) much longer than wide, striate only at extreme base, with a pair of long, dilated setae (? postocular) midway on the dorsum be-

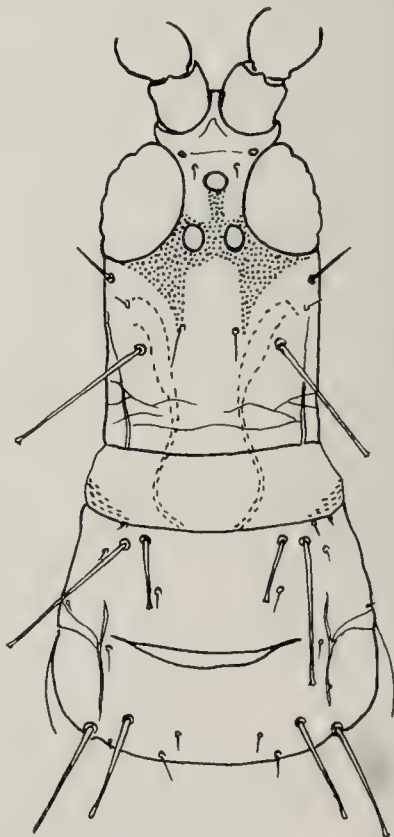


Fig. 277.—*Preeriella minuta*, head and prothorax.

tween the eyes and the base of the head. Antennae (Fig. 160) eight segmented. Maxillary stylets retracted far into the head, nearly parallel within the head.

Prothorax with anterolateral and major posterior setae long and dilated, anteromarginal setae well developed but only slightly more than one-half as long as anterolateral setae, midlateral setae minute. Metanotum faintly but definitely longitudinally striate medially. Fore legs unarmed.

Pelta divided into three parts (Fig. 278). Only one pair of wing-holding setae on each of abdominal tergites III-VII. Abdominal tergite IX with major posterior setae long, the middle pair dilated, the lateral pair pointed. Tube relatively short and slender.

MALE (macropterous).—Length distended about 0.9 mm. Similar to female in general color and structure. Abdominal sternite VIII apparently without a differentiated glandular area. Abdominal tergite IX as in female, major lateral posterior setae not shortened.

Of the two specimens in the type series in the Watson collection, the one selected here to be the lectotype is labeled "Type ♂, Gainesville, Fla., III-28-37, J. R. W., Sp. moss, S. W. Station Woods." The other slide marked "Type ♀" is actually a male collected according to the label "2-14-37," not "April 4, 1937" as stated in the protolog.

Preeriella minuta is one of the most distinctive thrips in Illinois. It can be easily recognized by the characteristics of its small size, the cup-shaped form of antennal segment III, and its

thin, threadlike wings. It is the only member of the genus in the United States. Another form (or undescribed species), with a darker head, has been taken in Vera Cruz, Mexico (INHS collections). The remainder of the species in *Preeriella* occur in South America.

First known from Florida, *minuta* has since been found in Alabama, Arkansas, Oklahoma, Texas, Missouri, and Illinois (INHS). In Illinois it has been collected mostly in the southern half of the state, always outside the terrain once covered by the Wisconsin glacier, usually in moist woodlands under fallen leaves.

Illinois records.—Collected during every season of the year, from one to several localities in the following counties: ALEXANDER, CALHOUN, CHRISTIAN, EFFINGHAM, HANCOCK, HARDIN, JACKSON, PERRY, PIKE, and POPE.

Sophiothrips Hood

Sophiothrips Hood (1934:425). Type-species by original designation.—*Sophiothrips squamosus* Hood.

Nanothrips Faure (1938:3). Type-species by original designation.—*Nanothrips breviceps* Faure. Synonymized by Hood (1954a).

Head (Fig. 279) wider than long, slightly prolonged in front of eyes; surface smooth or roughly hexagonally reticulate. Ocelli, when present, with fore ocellus projecting slightly beyond anterior margin of eyes. Interocellar setae prominent. Eyes moderate in size or number of facets greatly reduced, according to form. Postocular setae well developed, pointed. Antennae eight segmented, segment III as long as II, segment VI longest, segments VII and VIII closely joined but completely separated by a suture. Major males with a ventral hornlike projection between the bases of the antennae, much as in *Zaxenothrips*. Mouth cone moderate in size, rounded. Maxillary stylets not retracted into the head proper.

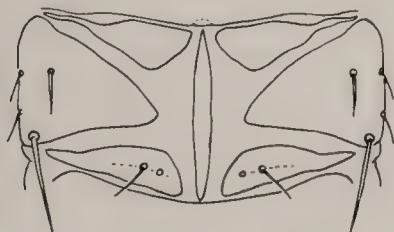


Fig. 278.—*Preeriella minuta*, pelta,

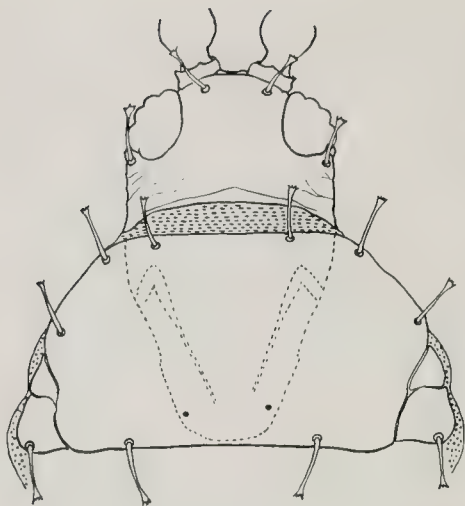


Fig. 279.—*Sophiothrips bicolor*, head and prothorax.

Prothorax enlarged, often longer than pterothorax, sometimes hexagonally reticulate. Frequently a single pair of epimeral setae the only setae well developed. Epimeral sutures complete. Praepectus (Fig. 147) present. Macropterous, brachypterous, and apterous. Mesopraesternum degenerate. Metafurcae well separated from or close to mesofurcae depending on form. Fore wings with sides parallel, not indented in the middle, without accessory cilia.

Pelta (Fig. 166 and 167) broad, never with posterior margin fractured into platelets. Abdominal tergites with or without wing-holding setae. In apterous male and female lateral major posterior setae on abdominal tergite IX shortened; in macropterous females, at least, these lateral setae much larger. Tube frequently longer than head, terminal setae shorter than tube.

Sophiothrips may be distinguished from those entities in which the maxillary stylets are confined to the mouth cone and rarely enter the head by the combination of the eight-segmented antennae in which segment III is as long as II and segment VI is the longest, the enlarged prothorax, and the entire pelta which is not fractured into platelets posteriorly as in *Zaxenothrips* and *Williamsiella*.

So far representatives of this genus have not been found in Illinois. Four species, some collected only once, are known from the United States around the gulf coast region. If any of these species do occur in Illinois, most likely they would be in the southern cypress and yellow pine section of our state.

KEY TO SPECIES (OF UNITED STATES, AS BASED ON LITERATURE)

1. Tube longer than head; one collection from northern Florida . . . **spadix** Hood
- Tube shorter than head 2
2. Femora entirely dark brown; one collection from southern Florida
- **vorticoides** Hood
- Femora dark brown tipped with yellow . 3
3. Prothoracic and many other setae dilated; half dozen collections from northern Florida
- **bicolor** Watson & Preer
- Prothoracic and most other setae pointed; several collections from southeastern Texas **unicolor** Hood

Williamsiella Hood

Williamsiella Hood (1925d:60).

Type-species by original designation.—*Williamsiella bicoloripes* Hood.

Head much broader than long, cheeks straight, dorsal surface smooth anteriorly, with weak anastomosing transverse striae posteriorly. Ocelli absent in apterous forms at least. Eyes small, with only six facets. Postocular setae long. Antennae seven segmented, segment II with dorsal sensoria located near middle of segment, segment III shorter and narrower than segments beyond it, morphological segments VII and VIII completely fused. Mouth cone heavy, broadly rounded at tip. Maxillary stylets when at rest retracted into head proper only a relatively short distance.

Pronotum broader than long, smooth with major anterior and lateral setae minute, posterior setae well developed. Epimeral sutures incomplete. Praepectus seemingly absent. Apterous only, so far as is known. Pterothorax degenerate, smooth. Fore tarsi one segmented, unarmed; mid and hind tarsi two segmented.

Abdomen broadest part of body.

Pelta broad with a large stipple-like area posteriorly. Wing-holding setae not differentiated. Lateral setae well developed, pointed. Abdominal tergite IX with major posterior setae longer than tube, pointed. Tube short, anal setae much shorter than tube.

This genus resembles some species of *Phthirotrips* and *Lissothrips* in the apterous form by being small and degenerate and having antennal segment III short. *Williamsiella* is distinguishable, however, in that the dorsal sensorium of antennal segment II is placed in a middle position rather than at the apex of the segment.

Only the type-species is known. As yet it has not been taken in Illinois. Because it is small and easily overlooked and because it occurs only 400 miles south of the Illinois border, *Williamsiella* is included as a remotely possible element of our fauna.

Williamsiella bicoloripes Hood

Williamsiella bicoloripes Hood (1925d: 60). ♀, ♂. Type-locality.—Trinidad.

FEMALE (apterous).—Length distended about 1.4 mm. Color dark brown, being darkest in abdominal segments VI–VIII and tube. Antennal segment I and most of the femora yellowish brown. Antennal segment II and inner apices of femora yellow. Setae brown becoming pale at tips. Body with much red subintegumental pigment.

Head as in Fig. 280. Eyes with four dorsal facets and two ventral facets. Ocelli absent. Postocular setae long, pointed. Antennal segment III nearly equal in length to segment II, pedicellate, without sense cones; segment IV with one inner and one outer sense cone.

Prothorax with anterior setae minute, midlateral setae slightly larger but still relatively small, epimeral setae longest, longer than prothorax.

Pterothorax with no wing sclerites differentiated. Mesospinasternum degenerate. Meso- and metafurcae joined.

Abdomen without sculpture. Pelta

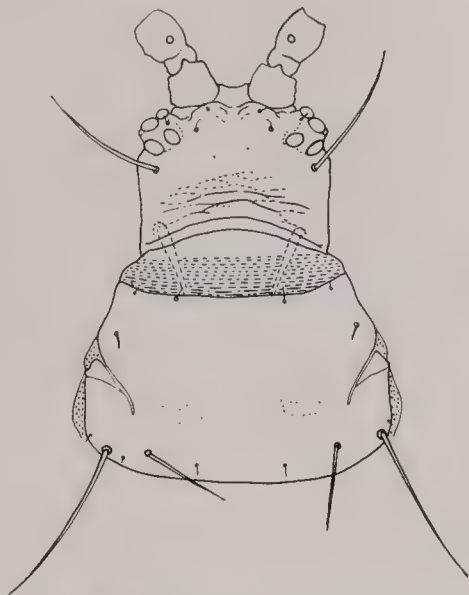


Fig. 280.—*Williamsiella bicoloripes*, head and prothorax.

as in Fig. 281. Abdominal segment X (tube) shorter than head, stout.

MALE.—Unknown to me. Described by the protologist as being "apterous . . . like female in all essential respects but smaller." The size of the lateral setae on abdominal tergite IX and whether abdominal glandular areas are present or absent have not been mentioned in the literature.

This monotypic species was discovered in Trinidad by C. B. Williams, then a young thysanopterist, on fag-gots. Watson subsequently collected a specimen, record not published, from Turkey Grove, Citra, Florida, March 3, 1922, on lichen on the trunk of an orange tree. Dr. H. H. Ross and I took another specimen from the leaf mold of an oak forest near Weston, Georgia, December 18, 1949. A year later, in a remote part of Chiapas, Mexico, at Finca Monte Libano and at Finca el Real, areas several days horseride from Ocosingo, I found a small series of specimens on dead citrus branches.

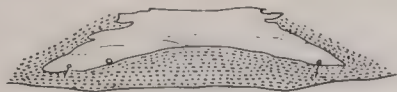


Fig. 281.—*Williamsiella bicoloripes*, pelta.

All of these specimens seemingly are true *bicoloripes*.

Possibly *bicoloripes* is a tropical or subtropical thrips able to extend into the temperate region about as far as citrus trees grow. Although there is little chance that this species may be found in Illinois, it is included here for reference as a member of our neighboring southeastern fauna, many other members of which extend into the extreme tip of southern Illinois.

***Zaxenothrips* Crawford, J. C.**

Zaxenothrips Crawford, J. C. (1943: 221). Type-species by original designation. *Zaxenothrips peculiaris* Crawford, J. C.

Head wider than long to about as wide as long, generally smooth except for faint subreticulate sculpture anteriorly. Major males with a ventral head horn between the insertions of the antennae and a ventral horn just anterior to the mouth cone. Cheeks often with a blunt toothlike projection behind eyes. Eyes small with about a dozen dorsal facets. Ocelli absent in apterous forms, present in macropterous forms. Interocellar setae developed. Postocular setae developed, pointed; in apterous major males a second pair of postocular setae developed. Antennae eight segmented, segment III longer than IV, segment VI the largest, segment VIII nonpedicellate, closely joined to segment VII. Mouth cone moderate in size, very broadly rounded. Maxillary stylets short, not retracted into the head proper.

Prothorax with major setae developed but anterior pairs small. Epimeral sutures complete. Praepectus absent in most forms, present in greatly developed major males. Fore legs enlarged, fore tarsi each armed with a tooth. Mid and hind femora, in males at least, with differentiated outer setae. Macropterous or apterous. Fore wings without accessory fringe cilia.

Pelta small, degenerate, posterior portion broken into small, stipple-like platelets. Wing-holding setae present in macropterous forms. In males, abdominal sternite VIII apparently

without glandular areas; abdominal tergite IX with major lateral setae reduced in size. Tube shorter than head, terminal setae shorter than tube.

Hood (1954a) sank *Zaxenothrips* under *Sophiothrips*. Although such action seems justifiable, I prefer to maintain *Zaxenothrips* as a separate entity until *Sophiothrips* is better known. It would seem from the literature that considerable differences separate some of the species assigned to *Sophiothrips* and, therefore, a reanalysis of the species and forms should be made to determine the exact limits of the genera involved.

Zaxenothrips may be recognized by the characteristics of *peculiaris*, the only species that occurs in Illinois. No species of *Sophiothrips* s. str. has been found in our region as yet.

***Zaxenothrips peculiaris* Crawford, J. C.**

Zaxenothrips peculiaris Crawford, J. C. (1943:224). ♀, ♂. Type-locality.—Bethesda, Maryland.

MALE (apterous, greater major form).—Length distended about 1.5 mm. General color dark brown. Inner apical angle of femora yellow. Antennal segments III–VI each pale yellow to nearly white in basal half, brown in apical half. Tube orange-brown except for gray-brown tip.

Head (Fig. 282) slightly wider than long, with hornlike processes on the ventral surface between the insertions of the antennae and at the base of the head anterior to the mouth cone. Eyes small with a dozen or fewer facets dorsally. Ocelli absent. One pair of interocellar and two pairs of postocular setae moderately stout and pointed. Antennal segment III with no inner and one short outer sense cone. Mouth cone moderate in size, broadly rounded.

Prothorax greatly enlarged. All major setae developed, the anterior pairs fairly short, the posterior pairs moderately long, all of these setae pointed. Praepectal plates present, but small. Completely apterous. Pterothorax degenerate. Mesopraesternum lacking. Meso- and metafurcae fused. Fore legs enormously enlarged; fore tarsi each

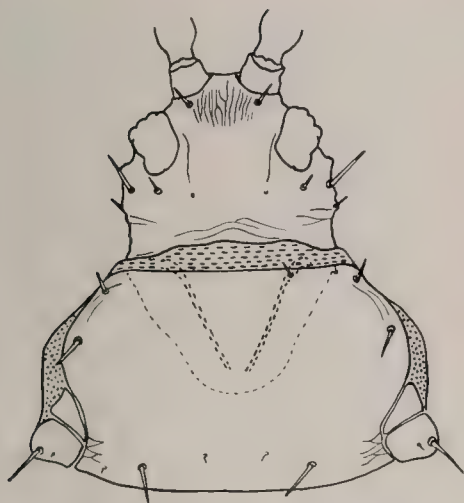


Fig. 282.—*Zaxenothrips peculiaris*, head and prothorax.

with a long, stout tooth; mid and hind femora each with a differentiated, stout, pointed, outer seta.

Pelta, as in Fig. 168, with an extensive stippled area posterior of pelta plate. Wing-holding setae not differentiated. Lateral setae heavy and pointed. Abdominal sternite VIII apparently without a glandular area. Abdominal tergite IX with major lateral setae much shorter than mid setae. Tube (Fig. 187) shorter than head.

MALE (apterous, lesser major form).—Length distended about 1.2 mm. Similar to the greater major male except for the following. Ventral head horns greatly reduced in size. Prothorax somewhat smaller, with major setae slightly reduced in size. Praepetalar plates absent. Fore legs less enlarged. Lateral setae of abdomen shorter.

FEMALE (macropterous).—Not known to me.

FEMALE (apterous).—Length distended about 1.3 mm. Similar to lesser major male except only one pair of postocular setae developed, fore legs only slightly enlarged, fore tarsi each with major posterior setae equal in size, tube mostly brown without orange.

This is one of the two species known to be in Illinois which do not have the maxillary stylets, when at rest, much,

if at all, retracted into the head proper. It is distinctive by its head shape and by the color and form of the antennae.

Our Illinois records constitute the total localities so far known outside the type locality in Maryland. The specimens collected in our state were obtained by beating dead branches.

Illinois records.—COLES COUNTY: Fox Ridge State Park, September 18, 1957, O'Neill, Stannard, dead hickory branches, 1 ♀, 1 ♂. EFFINGHAM COUNTY: Mason, September 2, 1955, Ross, Smith, Stannard, dead branch, 1 ♀.

Subfamily MEGATHRIPINAE Karny 1921

This subfamily comprises those members of the Tubulifera that have the maxillary stylets broad and band-like, whose males always lack abdominal glandular areas and never have the lateral pair of major, posterior setae (setae II of authors) on abdominal tergite IX spinelike or shorter than in the female.

Allothrips Hood

Allothrips Hood (1908c:372). Type-species by monotypy.—*Allothrips megacephalus* Hood.

Bryothrips Priesner (1925a:6). Type-species by original designation.—*Bryothrips pillichellus* Priesner. Synonymized by Stannard (1957b).

Head moderate in size, about as long as broad to longer than broad, prolonged moderately in front of eyes, dorsum smooth except for extreme anterior and base of head which are faintly hexagonally reticulate. Eyes in apterous form with less than a half hozen dorsal facets and in brachypterous form with less than a dozen dorsal facets. Ocelli absent in apterous form, present in brachypterous form. Interocellar, postocular, and middorsal setae well developed and dilated. Cheek setae pointed or dilated. Antennae seven segmented, morphological segments VII and VIII completely fused, all segments small, segments V and VI slightly prolonged ventrally at apex. Mouth cone broadly

rounded. Maxillary stylets in species from Illinois usually placed far apart and parallel when retracted into the head.

Prothorax with all major setae well developed and all about the same size, dilated, midposterior setae dilated in species from Illinois. Praepectus present. Mesopraesternum degenerate. Epimeral sutures complete or nearly so. Apterous or brachypterous. Thorax degenerate in apterous form. Fore legs unarmed in female, armed in male. Fore femora enlarged in major males. Mid and hind tarsi each two segmented.

Pelta fairly broad, as in Fig. 285. Wing-holding setae pointed, present only in brachypterous form. Tube short.

The seven-segmented antennae and the form of the head, especially in the characteristics of the small eyes, dilated head setae, and small tube distinguish this genus from all others in the Megathripinae in Illinois. Elsewhere I have reviewed the North American species and discussed their affinities (Stannard 1955a, 1957b). The genus *Diopsothrips* can be added as another allied entity.

Two species occur in our area. One, *megacephalus*, is statewide in distribution and is arboreal; the other *nubillicauda*, is restricted to the southern half of the state and is terrestrial.

KEY TO ADULTS

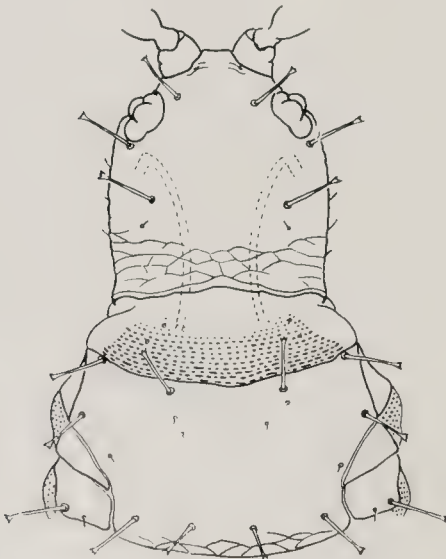
1. Predominantly brown; head (Fig. 283) with cheek setae small and pointed. *megacephalus*
- Predominantly yellow; head (Fig. 284) with cheek setae fairly prominent and dilated. *nubillicauda*

Allothrips megacephalus Hood

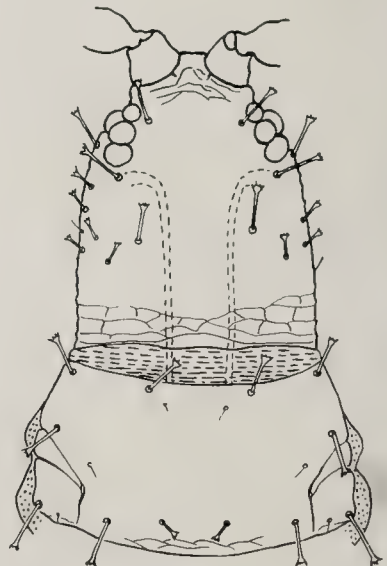
Allothrips megacephalus Hood (1908c: 373). ♀. Type-locality.—Not stated but holotype labeled Urbana, Illinois. Shull (1909:228). ♂.

FEMALE (apterous).—Length distended about 1.6 mm. General color dark brown. Tarsi and apex of antennal segment II yellow to yellowish brown. Setae nearly colorless.

Head (Fig. 283) about as wide as long. Postocellar, postocular, and mid-dorsal setae well developed, dilated. Cheek setae small and pointed. Eyes reduced to a few facets. Ocelli absent.



283



284

Fig. 283-284. Head and prothorax: 283, *Allothrips megacephalus*; 284, *Allothrips nubillicauda*.

Thorax smooth, not sculptured, degenerate as is typical of apterous forms. Prothorax with all major setae well developed, all about the same size, all dilated. Fore tarsi unarmed.

Pelta as in Fig. 285. Wing-holding setae not differentiated, dorsal abdominal setae, except terminal tube setae and minor setae, usually dilated. Tube short.



Fig. 285.—*Allothrips megacephalus*, pelta.

FEMALE (brachypterous?).—Length distended over 1.6 mm. Similar to apterous female with the following exceptions. Eyes larger. Ocelli present. Pterothorax not degenerate. (Wings or wing pads apparently removed in the single specimen in our collection.) Wing-holding setae well developed.

MALE (apterous).—Length distended about 1.1 mm. Similar to female except not as dark brown, often antennal segments I and II yellowish brown. Fore tarsi (Fig. 149) each armed with a strong tooth. Fore femora often enlarged.

This dark brown species can be easily distinguished from *nubillicauda* by the characteristics of the cheek setae as indicated in the foregoing key.

Allothrips megacephalus has been found in all parts of the state under dead bark, especially of oak trees.

Illinois records.—Collected from early April to the middle of November, from one to several localities in the following counties: ADAMS, CALHOUN, CHAMPAIGN, CRAWFORD, CUMBERLAND, EDGAR, FULTON, GRUNDY, HARDIN, JEFFERSON, KANKAKEE, LA SALLE, LAKE, MASON, MORGAN, PERRY, RANDOLPH, ROCK ISLAND, SANGAMON, UNION, VERMILION, and WHITESIDE.

Allothrips nubillicauda Watson

Allothrips nubillicauda Watson (1935: 60). ♀, ♂. Type-locality.—Gainesville, Florida.

Allothrips flavus Watson (1945:35). *Nomen nudum*. Referred to *Allothrips nubillicauda* by Stannard (1955a).

FEMALE (apterous) (Fig. 286).—Length distended 1.6–2 mm. General

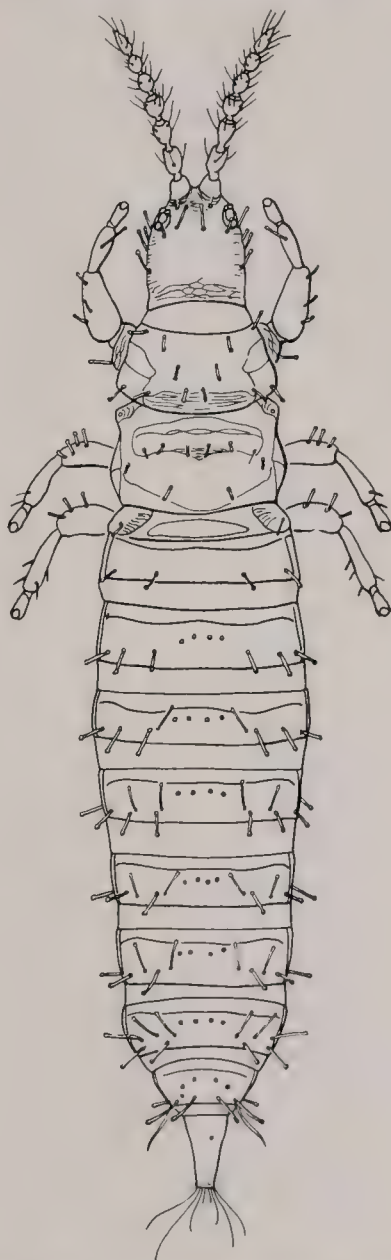


Fig. 286.—*Allothrips nubillicauda*, dorsal aspect.

color golden yellow with some brown. Brown overlying yellow: anterior of head; antennal segments I and III; anterior portions of abdominal tergites II-VI, most of VII and VIII, and posterior portions of I and IX. Brown: last four antennal segments and apex of tube. Eyes with red sub-integumental pigment.

Head (Fig. 284) longer than wide. Postocellar, postocular, and middorsal setae well developed, dilated. Cheek setae well developed, usually smaller than postocular setae, dilated.

Thorax generally smooth, only faintly sculptured with hexagonal reticulations, degenerate as is typical of apterous forms. Fore tarsi unarmed.

Pelta about as in Fig. 285. Wing-holding setae not differentiated, dorsal abdominal setae, except terminal tube setae and minor setae, strongly dilated. Tube slightly longer proportionately than in *megacephalus*.

MALE (apterous).—Length distended over 1 mm. Similar to female with the following exceptions. Head and abdomen with much less brown, often with brown coloration limited to the terminal antennal segments and apex of tube. Fore tarsi each armed with a strong tooth.

In North America this species is unique in having the strong, dilated cheek setae.

The lectotype from the Watson collection designated here is on the slide labeled in pencil "Type ♀ d" and in ink "Gainesville, Fla., 1-8-33, J.R.W., dead leaves, Bay, Holly, Carpinus, etc." Originally this slide was marked "*megacephalus*" but that name has been crossed off.

After intensive search, specimens have so far been taken almost exclusively in the southern half of Illinois outside the area covered by the Wisconsin ice sheet (Fig. 21). They have been found principally in forest ground litter.

Illinois records (Fig. 21).—Collected every month of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, BOND, CLAY, HAMILTON, HANCOCK, JACKSON, MACOUPIN, MARION, MAISON, MONROE, MONTGOMERY, MOR-

GAN, PERRY, PIKE, POPE, WASHINGTON, and WHITE.

Cryptothrips Uzel

Cryptothrips Uzel (1895:228). Type-species by subsequent designation of Hood (1916b).—*Cryptothrips lata* Uzel.

Head rectangular, elongate, much longer than wide, area bearing antennae not prolonged in front of eyes, dorsum smooth except for faint hexagonal reticulations at extreme sides and base of head. Eyes proportionately small. Postocellar setae minute or long. Postocular setae long, pointed. Ocelli present, reduced in size in brachypterous forms. Antennae (Fig. 156) eight segmented, segments IV-VII only moderately elongate and produced ventrally at apex, segment VIII slightly pedicellate. Mouth cone short and broadly rounded. Maxillary stylets, when retracted, touching within the center of the head.

Prothorax with major setae well developed, anterior pairs smaller than the posterior ones, all setae pointed to blunt. Epimeral sutures complete. Praepectus developed but often small. Anterior margin of mesosternum broad. Metanotum nearly smooth. Fore legs unarmed in female, armed in male. Macropterous or brachypterous. Fore wings, when fully developed, broad and with accessory fringe cilia.

Pelta moderate in size, usually hexagonally reticulate. Wing-holding setae present. Tube relatively long although shorter than the head, without long lateral setae.

These thrips, which are usually blackish brown, can be distinguished from *Diceratothrips*, a close relative in North America, by the placement of the maxillary stylets within the head. In *Cryptothrips* these stylets touch within the center of the head whereas in *Diceratothrips* they are placed V shaped within the head and never touch.

The only other blackish brown, rectangular-headed thrips of the Megathripinae likely to be encountered in

Illinois are species of *Megathrips* and *Megalothrips*. These species have hairy tubes, and by this characteristic *Megathrips* and *Megalothrips* can be separated from *Cryptothrips*, even with a hand lens.

Two species of *Cryptothrips* occur in Illinois. Both live under bark of dead branches where presumably they feed on fungus spores.

KEY TO SPECIES
(ILLINOIS, EXCEPT WHERE NOTED)

1. Postocellar setae long, nearly as long as postocular setae. *carbonarius*
Postocellar setae short, much shorter than postocular setae. 2
2. Antennal segment III almost entirely bright yellow; from Europe and possibly western U.S.A. *latus*
Antennal segment III yellowish brown or yellow heavily clouded with brown; from eastern U.S.A. *rectangularis*

Cryptothrips carbonarius Hood

Cryptothrips carbonarius Hood (1908c: 376). ♂. Type-locality.—Pulaski, Illinois.

Cryptothrips longiceps Hood (1912c: 153). ♀, ♂. Type-locality.—Carbondale, Illinois. Tentative synonymy by Stannard (1957b) confirmed.

FEMALE (macropterous).—Length distended about 3.7 mm. Color dark blackish brown except pedicel of antennal segment III which is yellow to yellowish brown. Wings colorless.

Head (Fig. 287) elongate, proportionately longer than in *rectangularis*, reticulate in basal half of dorsum. Postocellar setae long, as in Fig. 287. Postocular setae long and pointed. Ocelli present.

Prothorax in median length shorter than sclerotized portion of metanotum. All major prothoracic setae well developed, pointed, anterior pairs slightly longer than in *rectangularis*. Fore wings each with 18–22 accessory fringe cilia.

Abdominal tergite I with pelta similar to that illustrated in Fig. 172. Wing-holding setae strongly developed. Abdominal tergite IX with major posterior setae longer than tube.

FEMALE (brachypterous) (Fig. 288).

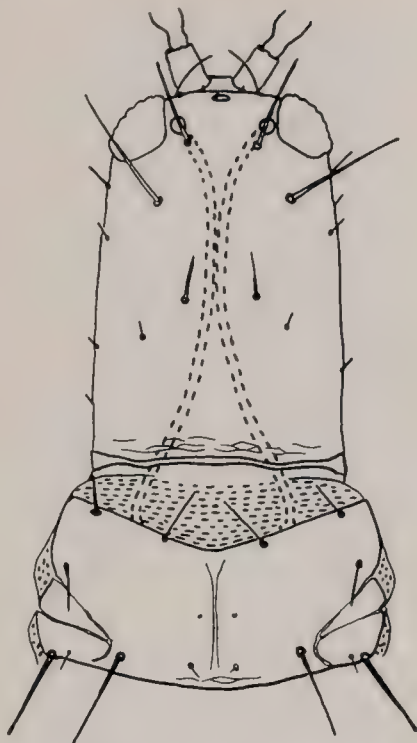


Fig. 287.—*Cryptothrips carbonarius*, head and prothorax.

—Length distended about 3.4 mm. Similar to macropterous female in general color and structure except ocelli reduced in size, prothorax in median length longer than sclerotized portion of metanotum, and wing-holding setae reduced in size.

MALE (macropterous).—Length distended about 2.7 mm. Similar in color and structure to macropterous female except that each fore tarsus is armed with a small or median-sized tooth and the fore wings each have 15–17 accessory fringe cilia.

MALE (brachypterous).—Unknown to me.

This species can be easily distinguished from *rectangularis* by the size of the postocellar setae. In *carbonarius* these setae are nearly as long as the postocular setae. In *rectangularis* the postocellar setae are hardly ever twice as long as the diameter of a posterior ocellus.

Because the length of the fore legs varies proportionately to the head

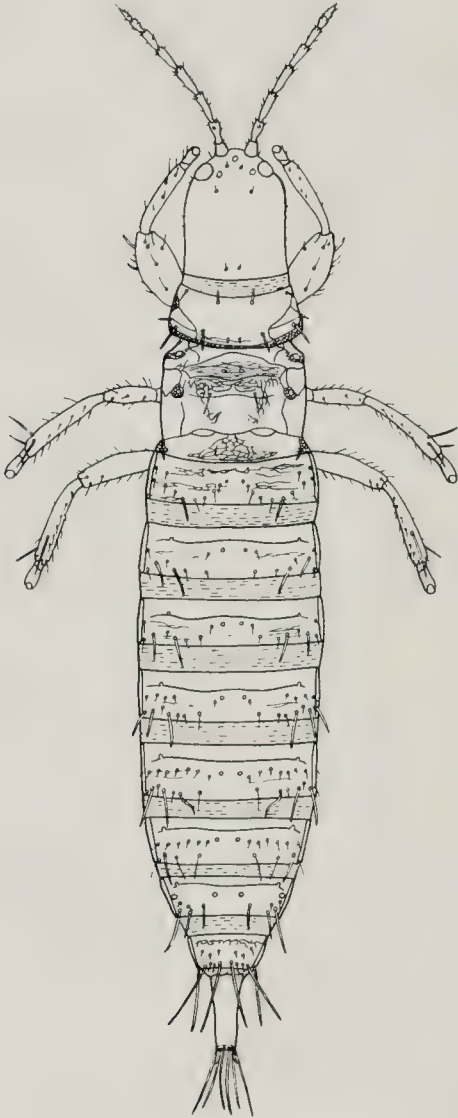


Fig. 288.—*Cryptothrips carbonarius*, ♀ brachypterous, dorsal aspect.

length, it was my conclusion that the form called *longiceps* was probably the representative of one extreme (Stannard 1957b). Accordingly I tentatively sunk *longiceps* under *carbonarius* even though at the time I had not seen the types. Since then I have studied the types and topotypical material from Pulaski, Illinois, and have satisfied myself that *longiceps* is an outright synonym of *carbonarius*.

Cryptothrips carbonarius has been taken only in the southern half of the state. It is most frequently found under bark of dead branches.

Illinois records.—Collected from May to October, from one to several localities in the following counties: ADAMS, HARDIN, JACKSON, JOHNSON, MASON, MORGAN, PIKE, PULASKI, and UNION.

Cryptothrips rectangularis Hood

Cryptothrips rectangularis Hood (1908a:307). ♀, ♂. Type-locality. —Urbana, Illinois (Hood 1927c).

Trichothrips salicis Watson (1921:80). ♂. Type-locality.—Cranberry Lake, New York. Synonymized by Hood (1927c).

FEMALE (macropterous).—Length distended slightly over 3 mm. Color dark blackish brown except pedicel of antennal segment III. Wings colorless.

Head faintly reticulate at sides and at base. Postocellar setae small, hardly larger than diameter of hind ocelli. Postocular setae well developed, pointed. Ocelli present.

Prothorax in median length shorter than sclerotized portion of metanotum. All major prothoracic setae well developed, pointed to blunt, anterior pairs smaller than in *carbonarius*. Fore wings each with about 18 accessory fringe cilia.

Abdominal tergite I with pelta as in Fig. 172. Wing-holding setae strongly developed. Abdominal tergite IX with major posterior setae shorter than tube.

FEMALE (brachypterous).—Length distended about 3 mm. Color dark brown except antennal segment III which is heavily clouded with brown over a yellow background. Similar in structure to macropterous female except ocelli greatly reduced, prothorax in median length longer than sclerotized portion of metanotum, and wing-holding setae reduced in size.

MALE (macropterous).—Length distended over 2.7 mm. Similar in color and structure to macropterous female except antennal segment III tending to be yellowish brown basally, fore

tarsi each armed with a strong tooth, and fore wings each with about 12 accessory fringe cilia.

MALE (brachypterous).—Length distended about 2.3 mm. Similar in color and structure to macropterous male except ocelli greatly reduced, prothorax in median length longer than sclerotized portion of metanotum, and wing-holding setae reduced in size.

In Illinois this species is easily distinguished from its only other congener by the short postocellar setae.

The exact status of *rectangularis* is not yet understood. According to Hood (1927c) *rectangularis* is so closely related to *latus*, a species originally described from Europe, that the former might be considered to be a subspecies of *latus*. Regardless of the taxonomic rank, almost certainly two entities are involved. In the West, it would seem that *rectangularis* is replaced by *latus*. Quite possibly the Californian specimens Cott (1956) relegated to *rectangularis* are instead *latus*. The bright yellow color of antennal segment III is a characteristic of *latus* and the western specimens described by Cott. Specimens of *rectangularis* from Illinois, on the other hand, have antennal segment III brown, or yellow heavily clouded with brown. Until these entities can be studied in series from many places, I prefer to limit the name *rectangularis* to those specimens with the darker antennae, which, presumably, are all eastern in distribution, and, as suggested by Hood in 1927, to retain *rectangularis* as a full species separate from *latus*.

Cryptothrips rectangularis occurs throughout Illinois under bark of dead branches.

Illinois records.—Collected from May to September inclusive, from one to several localities in the following counties: CARROLL, CHAMPAIGN (Hood 1908a), COOK, DE KALB, FAYETTE, HARDIN, HENDERSON, JACKSON, KANE, KANKAKEE, LAKE, LAWRENCE, LOGAN, MARION, MASON, MONTGOMERY, OGLE, PIKE, POPE, SANGAMON, VERMILION, WILL, and WHITESIDE.

Diopsothrips Hood

Diopsothrips Hood (1934:422). Type-species by original designation.—*Diopsothrips flavus* Hood.

Head slightly longer than wide, surface smooth. Eyes reduced in size to about six dorsal facets, the posterior facets being the largest. Ocelli present in macropterous forms, only fore ocellus present in brachypterous or apterous forms. Interocellar setae thickened. Postocular setae well developed. Antennae seven segmented, without a trace of a suture between morphological segments VII and VIII, segments III and IV with long sense cones. Mouth cone long, broadly rounded. Maxillary stylets thick, retracted far into the head, forming a wide V.

Prothorax mostly smooth, with all major setae well developed. Epimeral sutures incomplete. Metascutum weakly hexagonally reticulate. Macropterous, brachypterous, or apterous. Fore wings, when present, lacking accessory cilia. Fore tarsi armed in both sexes, mid and hind tarsi each two segmented.

Pelta degenerate in United States species at least, only posterior portion developed. Abdomen with lateral setae well developed, posteriorly becoming longer than the segments from which they arise. Abdominal tergite IX with major posterior setae long, some longer than tube. Tube longer than head, thickened, longitudinally ridged, sharply constricted at apex; anal setae much shorter than tube.

My previous supposition (1957b), based on the literature, that *Diopsothrips* was a synonym of *Polyphemothrips* is incorrect. Upon examination of authentic material I now find that *Diopsothrips* is not at all allied to *Symphyothrips*, as Hood implied in 1934, but instead is very close in structure to *Allothrips* and *Parallothrips*. Unlike these two genera, *Diopsothrips* has species bearing thick, long tubes. Possession of a broadly rounded mouth cone and thickened interocellar setae does not distinguish *Diopsothrips* from *Allothrips*, Hood's

statement (1934) to the contrary notwithstanding.

This genus is represented in the United States by one species, *louisianae*. It has not yet been found in Illinois.

***Diopsothrips louisianae* Hood**

Diopsothrips louisianae Hood (1936c: 98). ♀. Type-locality.—Tallulah, Louisiana.

FEMALE (apterous).—Length distended about 1.5 mm. General color brown. Head (except anterior region), median portions of pterothorax, apexes of femora, and all of tibiae and tarsi yellow. Antennal segment I light brown, segment II and pedicel of III yellow, remainder of antennae brown becoming darkest apically. Tube, except tip, orange. Body setae hyaline. Subintegumental pigment red.

Head as in Fig. 289, with cheeks smooth. Interocellar and postocular setae pointed. Antennal segment III moderate in size, longer than IV, with one inner and one outer sense cone;

segment IV with two inner and two outer sense cones.

Prothorax with all major setae pointed. Praepectus, if present, not discernible in the specimens I have seen. Metascutum with faint hexagonal reticulations. Wing pads entirely lacking. Fore tarsi with a moderate-sized tooth.

Pelta degenerate, anterior portion lacking, posterior portion hexagonally reticulate. Wing-holding setae present, slightly sigmoidal in form. All abdominal setae pointed. Tube longer than head, thick, ridged.

FEMALE (macropterous).—Unknown.

MALE.—Unknown.

This species has an *Allothrips*-like body, but is distinct in having a long, thick, orange tube.

To date it has been collected in Louisiana and Texas (USNM records) from humus and dead branches. Because many other Gulf coastal species extend up to the southwestern tip of Illinois via the Mississippi river valley, *louisianae* is included here as a possible Illinois inhabitant. Despite repeated searches, however, it has not been taken in our state as yet.

***Elaphrothrips* Buffa**

Elaphrothrips Buffa (1909:162). Type-species by subsequent designation of Moulton (1933b).—*Thrips schotti* Heeger. Invalid; *schotti* not in original list of *Elaphrothrips*. Type-species by subsequent designation of Andre (April 27, 1940).—*Idolothrips coniferarum* Pergande. Valid. Type-species by subsequent designation of Hood (October 18, 1940a).—*Idolothrips flavipes* Hood. Invalid; prior designation by Andre.

Dicaiothrips Buffa (1909:169). Type-species by subsequent designation of Bagnall (1910a).—*Thrips schotti* Heeger. Synonymized by Hood (1927c).

Head much wider than long, area bearing antennae prolonged in front of eyes, dorsal surface finely, transversely striate. Eyes moderate in size, occasionally produced posteriorly more on the venter than on the dorsum. Interocellar setae nearly as large

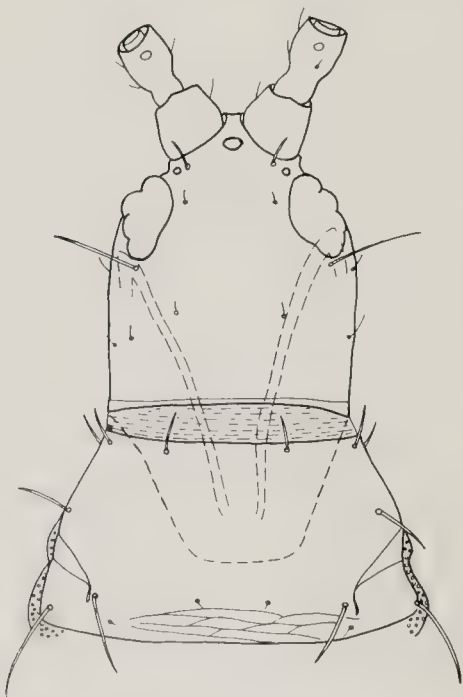


Fig. 289. *Diopsothrips louisianae*, head and prothorax.

as or larger than postocular setae, these setae always pointed. Ocelli present, fore ocellus often far forward. Cheeks with several pairs of setae which are often developed into strong spines. Antennae (Fig. 157) eight segmented, intermediate segments elongate, segment VIII usually with base constricted and more or less pedicellate. Mouth cone short, broadly rounded. Maxillary stylets placed V-shaped within head.

Prothorax with major setae well developed, anterior pairs smaller and not as prominent as the other setae, all setae pointed to blunt. Epimeral sutures complete. Praepectus well developed. Anterior margin of mesoepisternum short (Fig. 193). Mesonotum with many small, hexagonal reticulations. Fore legs usually armed, in males fore femora each often with a curved stout seta at apex. Macropterous, micropterous, or brachypterous. Fore wings, when fully developed, broad; fringe cilia numerous and closely spaced, each fore wing with 20-40 or more accessory fringe cilia.

Pelta broad, hexagonally reticulate, with lateral portions well differentiated from median portion. Remainder of abdominal tergites, except tube, predominantly sculptured with transverse striations, some of which grade into hexagonal reticulations. Abdominal segment IX in females with three pairs of long, pointed posterior setae; in males with an additional strong but shortened pair of ventral setae. Tube relatively long.

Because of Andre's revision (1940), the species from the eastern United States are well resolved as to their taxonomic status. By contrast representatives of *Elaphrothrips* in Central America are badly in need of critical treatment.

In Illinois the genus can be recognized by the large, prolonged head and by the narrow margin of the midanterior portion of the mesosternum.

Only four species occur in our state. Apparently they all feed on fungus spores growing in dead leaves. One of the species, *tuberculatus*, a dead oak leaves inhabitator (Fig. 37), is the largest thrips in Illinois.

KEY TO ADULTS

1. Tibiae and tarsi abruptly yellow; eyes prolonged ventrally more than dorsally **flavipes**
Tibiae, at least, dark brown to black ... 2
2. Pelta with lateral portions nearly separate from median portion; on conifers **coniferarum**
Pelta with lateral portions completely connected to the median portion in the posterior half 3
3. Fore ocellus overhanging; cheeks without many large spines; fore wings with a brown streak in the basal half. **armatus**
Fore ocellus not overhanging; cheeks with three or four pairs of large spines; fore wings with a brown streak at the extreme base only **tuberculatus**

Elaphrothrips armatus (Hood)

Idolothrips armatus Hood (1908b:285).
♀, ♂. Type-locality.—Not stated but holotype labeled Carbondale, Illinois. Transferred to *Elaphrothrips* by Hood (1927c).

FEMALE (micropterous) (Fig. 290).
—Length distended nearly 4.3 mm. General color blackish brown to black. Antennal segment III, except apex, and segments IV and V each in basal half yellow. Tarsi medium brown. Fore wings each with a dark brown median streak, basally.

Head (Fig. 291) proportionately longer and more slender than in *tuberculatus*, fore ocellus overhanging bases of antennae. Eyes not prolonged ventrally more than dorsally. Cheeks not bearing many large spines. Postocular setae long.

Fore femora without inner warts. Fore tarsi each armed with a small tooth. Fore wings short, degenerate, not reaching posteriad of abdominal segment III; accessory fringe cilia seemingly absent.

Abdominal tergite I with pelta having lateral portion broadly attached to median portion. Wing-holding setae well developed. Tube relatively long and slender.

FEMALE (macropterous).—Length distended about 5 mm. Similar to micropterous female except wings fully developed. Fore wings with brown median streak occupying all of basal half except extreme base; in speci-

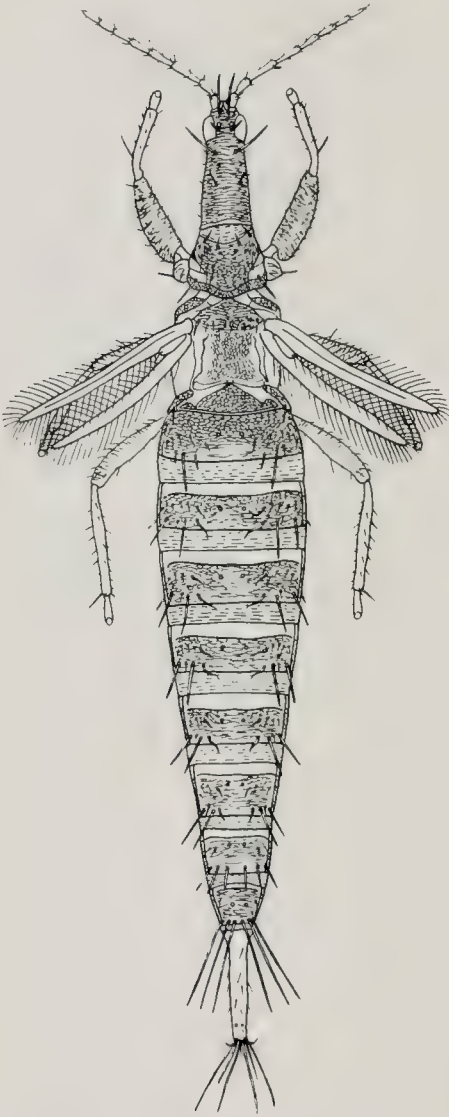


Fig. 290.—*Elaphrothrips armatus*, dorsal aspect.

mens from Lake City, Florida, each with 21 accessory fringe cilia.

MALE (macropterous).—Length distended more than 4.2 mm. Similar in color and structure to macropterous female with the following exceptions. Fore tarsi yellow, fore tarsal tooth larger and broader. Fore femora often enlarged and with many lateral spines well developed. Fore wings each with 17–22 accessory fringe cilia (Illinois specimens).

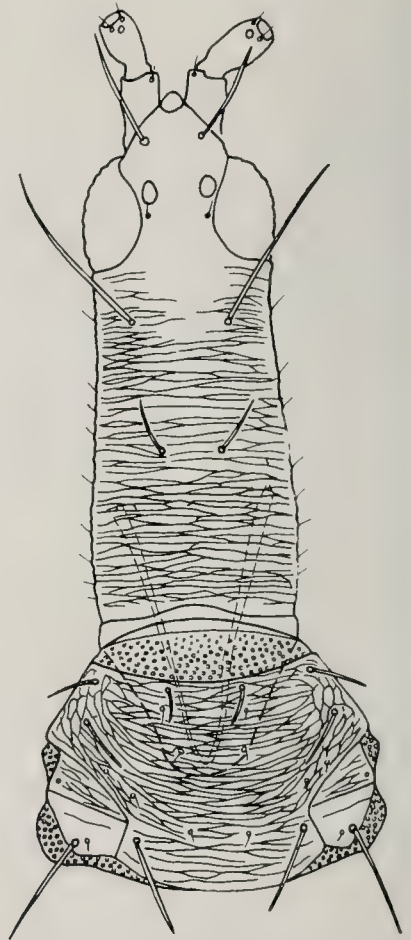


Fig. 291.—*Elaphrothrips armatus*, head and prothorax.

This long-headed species may be distinguished from *coniferarum*, which also has a brown median basal streak in each fore wing, by the form of the pelta. In *coniferarum* the lateral parts of the pelta are nearly separated from the median part; in *armatus* the lateral parts of the pelta are broadly joined to the median part. The species *tuberculatus*, which lacks a brown median streak in the fore wing, is also distinct from *armatus* by possessing warts on the fore femora in the female and by the proportionately shorter and broader head.

Ordinarily the females of *armatus* are more often micropterous than macropterous and the males are usually, if not always, macropterous.

During the cold months *armatus* may be found in the forest leaf litter or in hollow stems of herbs such as *Solidago*. In the warm months it can be found on herbs where the forests and prairies meet or in grassy glades within the forest. This thrips occurs throughout the state.

Illinois records.—Collected every month of the year, from one to several localities in the following counties: ADAMS, ALEXANDER, BOND, CHAMPAIGN, CLARK, CUMBERLAND, GREENE, GRUNDY, IROQUOIS, JACKSON, JEFFERSON, KANKAKEE, LAWRENCE, LEE, LOGAN, MASON, MONROE, MORGAN, PIATT, POPE, PULASKI, UNION, VERMILION, and WASHINGTON.

***Elaphrothrips coniferarum* (Pergande)**

Idolothrips coniferarum Pergande (1896:63). ♀, ♂. Type-locality.—Washington, D. C. Transferred to *Elaphrothrips* by Buffa (1909).

FEMALE (macropterous).—Length distended over 5.5 mm. General color blackish brown. Antennal segment III in basal two-thirds, segment IV in basal half, segment V in basal one-third, and segment VI in pedicel yellow. Fore wings in basal half with median brown streak.

Head (Fig. 292) moderately long and broad. Fore ocellus overhanging bases of antennae. Cheeks bearing three or four pairs of fairly stout setae. Eyes not prolonged ventrally more than dorsally. Postocular setae long in specimens from southern Illinois, shorter in specimens from northern Illinois.

Fore femora without inner warts. Fore tarsi each with a small tooth. Fore wings well developed, each with 32–42 accessory fringe cilia.

Abdominal tergite I with pelta having lateral portions nearly separate from median portion. Wing-holding setae well developed, sigmoidal. Tube relatively long and slender.

MALE (macropterous).—Length distended slightly over 5 mm. Similar to female in color and structure except fore tarsal tooth well developed and fore femora often enlarged.

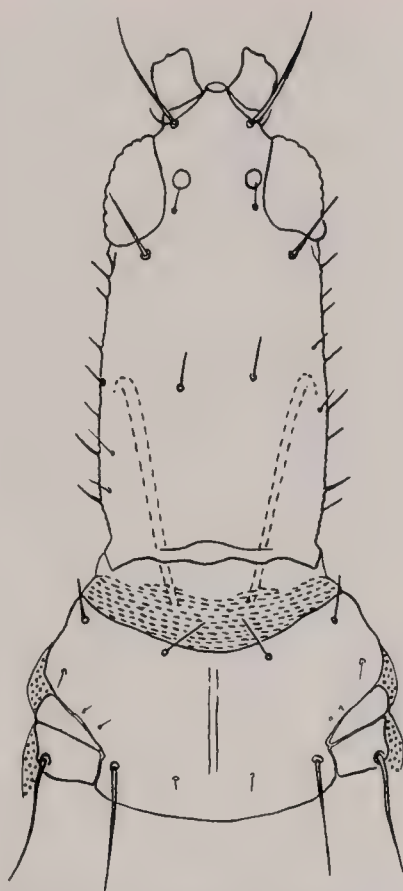


Fig. 292.—*Elaphrothrips coniferarum*, head and prothorax.

This species is easily distinguished from its congeners in Illinois by the form of the pelta in which the lateral portions are nearly separated from the median portions. No other species has the lateral portions so separated. Like *armatus*, *coniferarum* bears a brown median streak in the basal half of each fore wing.

Specimens from northern Illinois and the Atlantic states bear much shorter postocular setae than do specimens from southern Illinois.

As implied by its name, *coniferarum* inhabits conifers—in Illinois, white pine and red cedar.

Illinois records.—JOHNSON COUNTY: Vienna, August 17, 1950, Stannard, dead red cedar needles, 6 ♀, 2 ♂, 3 larvae. OGLE COUNTY:

White Pines State Park, July 13, 1944, Frison, Sanderson, white pine needles, 4 ♀, 2 ♂, 1 larva.

***Elaphrothrips flavipes* (Hood)**

Idolothrips flavipes Hood (1908c:377). ♀, ♂. Type-locality.—Not stated but holotype labeled Dubois, Illinois. Transferred to *Elaphrothrips* by Buffa (1909).

FEMALE (brachypterous).—Length distended over 4.5 mm. General color dark brown. Antennal segments III, IV, basal three-fourths of V, basal half of VI, tibiae, and tarsi bright yellow.

Head moderately long and broad. Fore ocellus overhanging bases of antennae. Cheeks bearing three or four pairs of fairly stout setae. Eyes prolonged ventrally more than dorsally. Postocular setae long.

Fore femora without inner warts. Fore tarsi each with a small tooth. Wing pads membranous, sometimes extending posteriorly to abdominal segment II.

Abdominal tergite I with pelta as in Fig. 293. Wing-holding setae slightly reduced in size. Tube moderately long and slender.

FEMALE (macropterous).—Length distended over 4.5 mm. Similar to brachypterous female except wings fully developed. Fore wings without basal brown streak, each with about 26 accessory fringe cilia.

MALE (brachypterous).—Length distended slightly less than 4.5 mm. Similar in color and structure to brachypterous female except fore tarsal tooth larger and sometimes fore legs greatly enlarged.

Elaphrothrips flavipes may be immediately recognized by the yellow color of the tibiae and the ventrally prolonged eyes. It occurs mostly in the southern half of our state in forest

debris or in low grasses and herbs at the edge of the forest.

Illinois records.—ALEXANDER COUNTY: Gale, November 18, 1959, Stannard, forest debris, 4 specimens; Olive Branch, March 15, 1960, Stannard, forest debris, 1 ♀, 1 ♂. CHAMPAIGN COUNTY: Homer (Hood 1908); Urbana, October 30, 1933, Farrar, soil and leaves, 1 ♀. CUMBERLAND COUNTY: Greenup, March 5, 1949, Smith, forest debris, 1 ♀. GALLATIN COUNTY: Shawneetown, June 23, 1950, Sanderson, sweeping vegetation, 1 ♀. PERRY COUNTY: Pyatts, April 11, 1956, October 28, 1964, November 12, 1964, Stannard, woodland debris, many specimens. POPE COUNTY: Herod, May 4, 1950, Sanderson, Stannard, sweeping grasses, 2 ♀. WASHINGTON COUNTY: Dubois, April 28, 1908, Hart, Smith, dead oak leaf, 1 ♂. WAYNE COUNTY: Zenith, April 22, 1966, Stannard, woodland leaf mold, 3 ♀.

***Elaphrothrips tuberculatus* (Hood)**

Idolothrips tuberculatus Hood (1908b:287). ♀, ♂. Type-locality.—Not stated but holotype labeled White Heath, Illinois. Transferred to *Elaphrothrips* by Hood (1927c).

FEMALE (macropterous).—Length distended nearly 5.8 mm. General color dark brown to black. Antennal segment III in basal two-thirds, segments IV and V each in basal half, and VI in basal third yellow. Tarsi lighter brown than body. Fore wings clear except for a brown streak at extreme base.

Head moderately long and broad, fore ocellus not overhanging bases of antennae. Cheeks with three or four very strongly developed, stout spines. Eyes not projecting posteriorly more on the venter than on the dorsum. Postocular setae long.

Fore femora each with an inner subapical wart (Fig. 294). Fore tarsi each with a small, anteriorly directed tooth. Fore wings each with about 40 accessory fringe cilia.

Abdominal tergites with wing-holding setae well developed. Tube long and slender.



Fig. 293. *Elaphrothrips flavipes*, pelta.

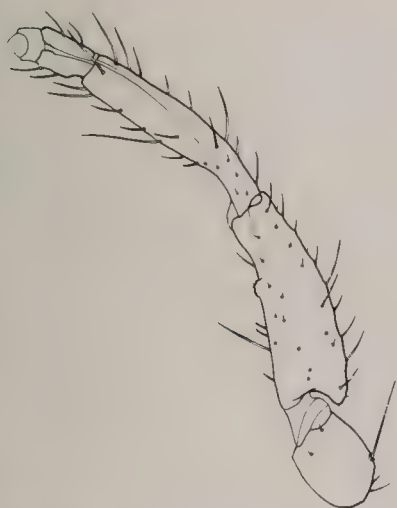


Fig. 294.—Fore leg of *Elaphrothrips tuberculatus*, ♀ showing wartlike process on femur.

MALE (macropterous).—Length distended nearly 5.5 mm. Similar to female in color and structure except for the following. Cheek spines larger. Fore tarsal tooth greatly enlarged and directed laterally. Fore femora without inner warts, or warts greatly reduced.

This is our largest thrips. The female is distinctive by the possession of a wart on the inner surface of each of the fore femora, and the male by the heavy spines on the cheeks. *Elaphrothrips tuberculatus* does not have an extensive brown basal streak in the fore wing.

This species occurs in dead hanging oak leaves (Fig. 37) throughout our state.

Illinois records.—Collected from May through November, from one to several localities in the following counties: ALEXANDER, CARROLL, CLARK, CLAY, COOK, EDGAR, HARDIN, JACKSON, JEFFERSON, JOHNSON, LA SALLE, MACON, MCLEAN, MONROE, OGLE, PIATT, POPE, UNION, and VERMILION.

Illinothrips Stannard

Illinothrips Stannard (1954:193).

Type-species by original description.—*Illinothrips rossi* Stannard.

Head longer than wide, prolonged in front of eyes, constricted behind

eyes. Eyes bulged in the manner of some *Eurythrips*. Ocelli absent in apterous forms. Cheeks without strong setae. Postocular setae well developed. Antennae eight segmented, intermediate segments not particularly elongated, segment VIII slender and well separated from segment VII. Mouth cone broadly rounded. Maxillary stylets when retracted placed in a V shape within the head.

Prothorax with all major setae well developed. Epimeral sutures often incomplete. Praepectus present. Mesopraesternum as in Fig. 148. Pterothorax in apterous form degenerate. Males with a pair of spinelike processes anterior to the mesospiracles. Only apterous forms known. Fore tarsi unarmed in female, armed in male.

Pelta as in Fig. 173. Abdomen only faintly sculptured. Wing-holding setae not differentiated in apterous form. Abdominal tergite IX with posterior setae shorter than tube. Tube shorter than head.

As concerns the Illinois fauna, *Illinothrips* resembles *Allothrips* most closely. The two are easily separated, however, by the form of the antennae—in *Illinothrips* the antennae are eight segmented whereas in *Allothrips* they are seven segmented. Relatives even closer to *Illinothrips* occur to the south and include *Pseudocryptothrips* and *Goetothrips*. None of the latter relatives have eyes bulged in the manner of *Illinothrips* nor are they sympatric with *Illinothrips* as far as is known.

The single species, *rossi*, has been collected in several localities in Illinois.

Illinothrips rossi Stannard

Illinothrips rossi Stannard (1954:195).

♀, ♂. Type-locality.—Elgin, Illinois.

FEMALE (apterous).—Length distended 2.3–2.5 mm. Color brown and yellow. Head, legs except outer basal edge of tibiae, tip of antennal segment II, and base of segment III yellowish. Pterothorax yellowish brown. Rest of body dark brown except abdominal segment IX which is often slightly

lighter. Body setae pale yellow to colorless.

Head as in Fig. 295, dorsal surface reticulate at base, striate at sides, and nearly smooth medially. Postocular setae blunt. Antennal segment III with one outer sense cone.

Prothorax with major setae blunt. Fore tarsi unarmed.

Abdominal segments without extremely long setae laterally. Tube nearly two-thirds as long as dorsal length of head.

MALE (apterous).—Length distended 1.6–1.8 mm. Similar to female with the following exceptions. Much lighter in color, most of body yellow except antennal segments I and IV–VIII (being darkest in the terminal segments), abdominal segments VII and VIII in the posterior margin, and abdominal segments IX and X (tube) in the posterior half. Thorax with each anterior margin of the mesospiracle

bearing a spinelike process (Fig. 145). Fore tarsi each armed with a sharp tooth.

This distinctive species, easily recognized by the generic characteristics, has been found only in Illinois and then in but a few scattered localities. It has been collected from clumps of *Andropogon scoparius*.

Illinois records.—COOK COUNTY: east of Elgin (Shoefactory Road hill prairie), August 1, 1944, Ross, Sommerman, 1 ♀; east of Elgin (Shoefactory Road hill prairie), October 10, 1952, Ross, Stannard, on *Andropogon scoparius*, 1 ♀, 1 ♂. MASON COUNTY: Bath, October 2, 1951, Sanderson, Stannard, on *Andropogon scoparius*, 7 ♀, 3 ♂, 3 immatures; Teheran, October 20, 1953, Smith, Stannard, on *Andropogon*, 1 ♀, 2 ♂.

Megalothrips Uzel

Megalothrips Uzel (1895:224). Type-species by subsequent designation of Priesner (1949).—*Megalothrips bonannii* Uzel.

Head elongate, much longer than wide and relatively more slender than in *Megathrips*, highly arched dorsally, with transverse striae, area beyond eyes only slightly projecting beyond anterior eye margin. Eyes moderate in size although proportionately small when compared to head size. Ocelli present. Interocellar, postocellar, and postocular setae well developed. Cheeks with several pairs of spines. Antennae eight segmented, segments VI and VII ventrally produced at apex, segment VIII lanceolate. Mouth cone short and broadly rounded. Maxillary stylets long, when at rest retracted to the eyes, touching within the center of the head.

Prothorax short, much shorter than in *Megathrips*, all major setae well developed, the posterior pairs being the longest, the anterolateral pair being closer to the anterior margin than in *Megathrips*. Epimeral sutures incomplete. Praepectus present. Mesopraesternum broad. Fore tarsi unarmed or each armed at the most with a tiny tooth. Only the macropterous form

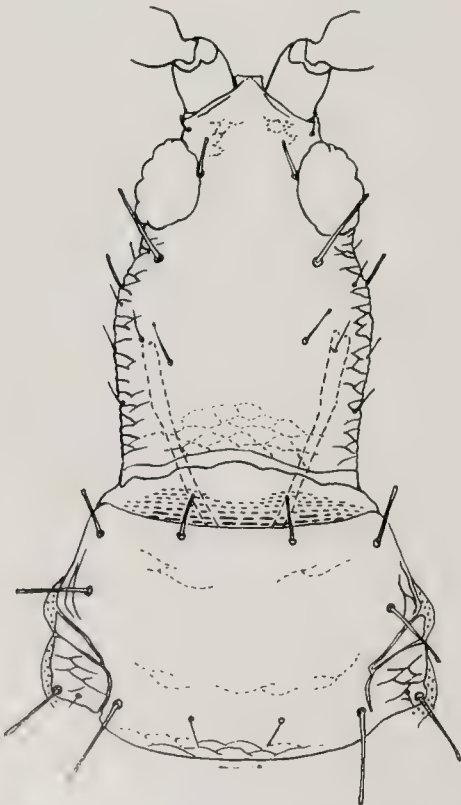


Fig. 295. *Illinothrips rossi*, head and prothorax.

found in Illinois. Fore wings broad with accessory fringe cilia.

Pelta with a median portion and two lateral portions that are either separated or connected by a slender bridge. Abdominal tergites with anterior halves hexagonally reticulate, posterior halves transversely striate. Wing-holding setae well developed. Abdominal tergite VI in male with a pair of long, tubular lateral processes. Tube long, bowed, and hairy; longer in female, shorter in male; with dorsal warts in the male, at least in the species from Illinois.

This genus is easily recognized in Illinois by the black color, large size, arched head, closely spaced maxillary stylets, and hairy tube. It resembles *Megathrips*, which occurs only in the northern part of our state, as well as many genera in the Old World tropics, such as *Caudothrips* and *Bacillothrips*.

One species, *Megalothrips spinosus*, is found in Illinois.

Megalothrips spinosus Hood

Megalothrips(?) *spinosus* Hood (1908a: 306). ♀. Type-locality.—Harrisburg, Pennsylvania.

FEMALE (macropterous).—Length distended about 5 mm. Color almost entirely blackish brown. Wings colorless.

Head (Fig. 296) elongate, arched dorsally, with transverse striae. Interocellar setae long, as long as postocular setae; postocellar setae well developed but smaller than postocular pair; these head setae pointed. Antennal segment III with one inner and one outer sense cone.

Prothorax brokenly transversely striate, with major setae pointed to blunt, the anterior pairs shorter than the posterior pairs. Mesopraesternum broad. Metanotum transversely striate to somewhat reticulate. Fore tarsi each usually armed with a tiny, blunt tooth at the inner apex. Fore wings each with 26–36 accessory fringe cilia.

Pelta as in Fig. 297. Wing-holding setae strongly developed. Abdominal tergite IX with major posterior setae shorter than the tube, yellowish brown

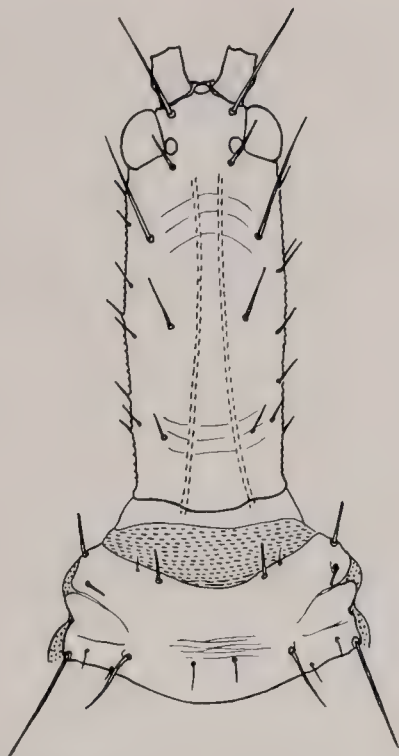


Fig. 296.—*Megalothrips spinosus*, head and prothorax.

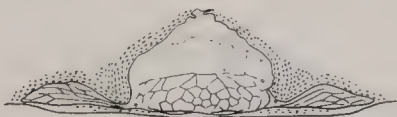


Fig. 297.—*Megalothrips spinosus*, pelta.

to yellow in color. Tube long, bowed, and hairy (Fig. 191).

MALE (macropterous).—Length distended over 4 mm. Similar to female in color and structure except for the following. Fore tarsi seemingly not armed. Abdominal tergite IV with a pair of lateral tubelike processes (in life these tubes are directed nearly straight upwards; when specimens are mounted and under the pressure of the cover glass they are directed posteriad and nearly on the plane of the body). Abdominal tergite VIII with the anterior wall of each spiracle projected slightly as a toothlike process. Tube proportionately shorter and thicker than in female, with four or more middorsal lateral warts.

Because there are no other congeners in Illinois, this species can be determined by the generic characteristics. The three North American species were keyed by J. C. Crawford in 1947.

Megalothrips spinosus is found throughout most of the state on dead branches.

Illinois records.—Found in all seasons of the year, from one to several localities in the following counties: ALEXANDER, CHAMPAIGN, CLARK, CLAY, COOK, JACKSON, LAKE, LAWRENCE, MACON, MASSAC, McDONOUGH, PIKE, POPE, PULASKI, RANDOLPH, WABASH, and WASHINGTON.

Megathrips Targioni-Tozzetti

Megathrips Targioni-Tozzetti (1881: 120). Type-species by monotypy.—*Megathrips piccioli* Targioni-Tozzetti (= *Phloeothrips lativentris* Heeger).

Head elongate, but shorter and broader than in *Megalothrips*, not strongly arched, with transverse striae, area beyond eyes moderately projecting. Eyes moderately sized. Ocelli present, reduced in size in brachypterous forms. Interocellar, postocellar, postocular, and middorsal head setae well developed; interocellar setae often longest. Cheeks with several pairs of capitate spines. Antennae eight segmented, segment III elongate, segment VIII lanceolate. Mouth cone broadly rounded. Maxillary stylets fairly long, when at rest retracted to the middle of the head, spaced fairly wide apart, not touching in the center of the head.

Prothorax not as short as in *Megalothrips*, all major setae well developed, the posterior pairs the longest, anterolateral setae displaced from anterior margin toward the midlateral setae. Epimeral sutures incomplete in brachypterous forms, complete or nearly complete in macropterous forms. Praepectus present. Mesopraesternum broad. Fore tarsi unarmed in the female, at the most each with a minute tooth in the male. Macropterous or brachypterous. Fore wings broad with accessory setae.

Pelta with a broad median portion, narrowly connected laterally to two small portions. Abdominal tergites with wing-holding setae well developed. Abdominal tergite VI in the male with a pair of long, tubular lateral processes. Abdominal tergite VIII in the male with lateral spines borne on produced areas. Abdominal tergite IX with major posterior setae less than one-third as long as tube. Tube moderately long, conspicuously hairy, constricted near the middle in the male. Anal setae much shorter than tube.

This genus resembles *Megalothrips* in name, in possessing hairy tubes, and in being large and dark in color. *Megathrips* may be distinguished by the close placement of the anterolateral setae to the midlateral setae and by the widely spaced maxillary stylets.

A single species, the holarctic *lativentris*, occurs in Illinois.

Megathrips lativentris (Heeger)

Phloeothrips lativentris Heeger (1852: 479). ♂. Type-locality.—Austria. Transferred to *Megalothrips* by Uzel (1895). Transferred to *Megathrips* by Priesner (1920a).

Phloeothrips longispina Reuter (1879: 214). ♂. Type-locality.—Finland. Synonymized by Uzel (1895).

Phloeothrips tibialis Reuter (1879: 215). ? ♀. Type-locality.—Finland. Synonymized by Uzel (1895).

Megathrips piccioli Targioni-Tozzetti (1881:120). ? ♀. Type-locality.—Italy. Synonymized by Priesner (1928).

Megalothrips niger Schmutz (1909b: 346). ? ♀. Type-locality.—Romania. Synonymized by Priesner (1928).

Bacillothrips padewiethi Karny (1919: 114). ♂. Type-locality.—Croatia (Yugoslavia). Synonymized by Priesner (1928).

FEMALE (brachypterous).—Length distended nearly 4 mm. General color blackish brown. Base and apex of femora, all of the tibiae and tarsi, antennal segment III except at apex, antennal segments IV and V in basal half, and antennal segment VI in pedi-

cel yellow. Body setae yellow. Wings colorless.

Head sharply constricted posteriorly, widest at eyes and middle of head. Ocelli small. Interocellar setae longest. Antennal segment III with one inner and one outer sense cone.

Prothorax weakly sculptured, major setae blunt to dilated. Metanotum smooth medially. Fore tarsi unarmed. Wings reduced to small pads.

Pelta as in Fig. 298, weakly sculptured. Abdominal tergites hexagonally reticulate anteriorly, more or less smooth posteriorly. Wing-holding setae reduced in size. Tube moderately long, not indented in the middle.

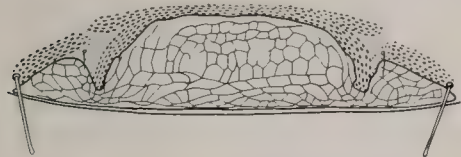


Fig. 298.—*Megathrips lativentris*, pelta.

FEMALE (macropterous).—Not available to me. Each fore wing reported to bear 25 accessory setae.

MALE (brachypterous).—Length distended about 3.5 mm. Similar to female in color and general structure. Fore tarsi each possibly with a minute tooth. Abdominal tergite VI with lateral finger-like process. Abdominal tergite VIII with lateral warts. Tube decidedly constricted in middle.

The generic characteristics should serve to distinguish the sole species in our area.

So far only one female specimen of *lativentris* has been taken in Illinois. Generally it is a northern species, occurring in the whole of Europe, in eastern Canada, New England, and south and west to Colorado, Minnesota, and northern Illinois.

Illinois record.—LAKE COUNTY: Barrington, September 21, 1961, Holmes, Stannard, forest debris, 1 ♀.

Nesothrips Kirkaldy

Nesothrips Kirkaldy (1907:103). Type-species by monotypy.—*Nesothrips oahuensis* Kirkaldy.

For more than 35 years, from the time of its origin until about a decade ago, *Nesothrips* remained an unrecognizable name. In 1944 Bianchi redescribed the type-species and made the genus known. According to my later interpretations (1957b), *Nesothrips* was actually no more than a complex in a genus which contained *Bolothrips* and *Gastrothrips*. Because *Nesothrips* is the older name, it is employed here, and *Bolothrips* and *Gastrothrips* are considered subgenera. No member of *Nesothrips* s. str. occurs in eastern North America.

Many species of *Nesothrips* bear close resemblance to some species in *Cryptothrips*. Species of *Nesothrips* can be distinguished easily by the V-shaped placement of the maxillary stylets when the stylets are retracted within the head. By contrast, in *Cryptothrips* these stylets lie parallel and close together within the head.

Nesothrips subgenus **Bolothrips** Priesner

Bolothrips Priesner (1926b:90). Type-species by original designation.—*Phloeothrips bicolor* Heeger. Subordinated under *Nesothrips* by Stannard (1957b).

Bolothrips subgenus *Botanothrips* Hood (1939a:605). Type-species by original designation.—*Bolothrips* (*Botanothrips*) *pratensis* Hood. Synonymized by Stannard (1957b).

As pertains to the Illinois fauna:

Head more or less oval to oblong, usually longer than broad, often slightly protruding anterior of eyes. Cheeks without strong setae. Eyes often protruding slightly, ventral surface often extended posteriad more than on dorsal surface. Ocelli present or absent, usually greatly reduced even in macropterous specimens. Postocular setae well developed and pointed. Postocellar setae small or moderately large. Antennae eight segmented, intermediate segments only slightly elongate, segment VIII well separated from segment VII. Mouth cone short and broadly rounded. Maxillary stylets placed V shaped within the head.

Prothorax with all major setae well developed except anteromarginal pair which are relatively small. Epimeral sutures complete. Praepectus well developed. Fore legs unarmed in female, usually armed in male, always armed in major male. Females either macropterous or apterous, males only apterous as far as is known. Fore wings, when fully developed, broad, each with about 10 accessory fringe cilia.

Abdomen usually smooth or only faintly sculptured. Pelta formed as in Fig. 303, with posterior half bearing weak striations. Abdominal segment IX in female with three pairs of moderately long, pointed posterior setae; in males with an additional fairly long pair of ventral setae. Tube moderate in size, more than half as long to nearly as long as head, usually not abruptly constricted near apex (Fig. 299).

This subgenus contains two groups, those with eyes greatly prolonged ventrally (for example, *bicolor*) and those

with eyes hardly at all prolonged ventrally (for example, *icarus*). Names have been applied to these groups as indicated in the synonymy. Unfortunately, when species from all over the world are considered, these categories break down. In other regions there are species which range from those with the eyes just slightly prolonged ventrally to various degrees of prolongation. It does not seem practical, therefore, to recognize these subdivisions as groups with legal names.

In the eastern United States and Canada, exclusive of Florida, this subgenus may be distinguished from the others in the subfamily Megathripinae by the relatively short head, the V-shaped position of the maxillary stylets when retracted within the head, the form of the pelta, and the cylindrical, nonridged black tube.

So far only two species, *bicolor* and *dentipes*, have been found in Illinois. Three more species have been taken in eastern states.

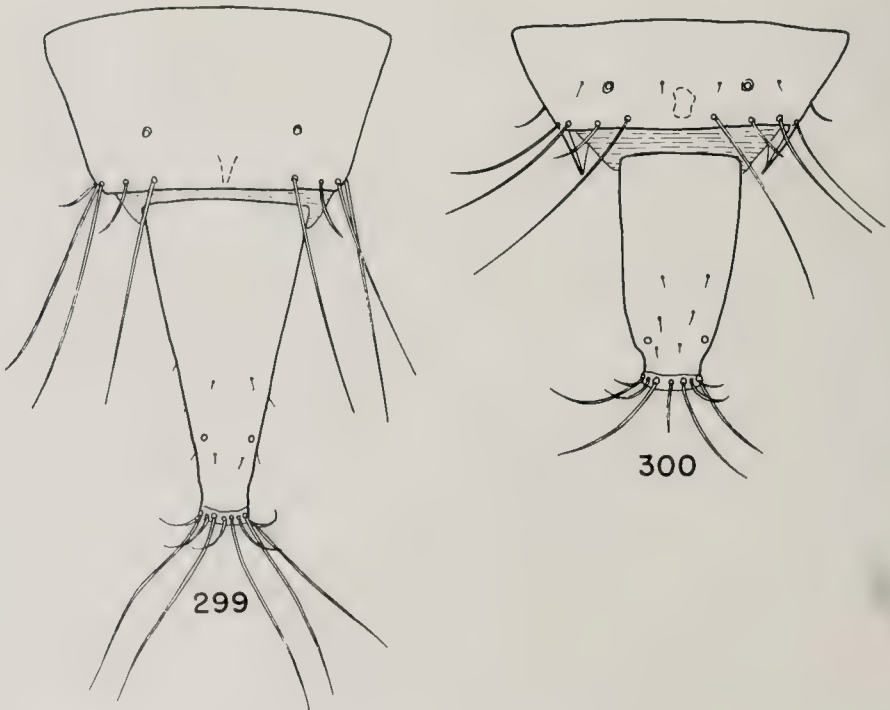


Fig. 299-300. —Abdominal tergites IX and X: 299, *Nesothrips (Bolothrips) bicolor*; 300, *Nesothrips (Gastrothrips) ruficauda*.

KEY TO SPECIES

(OF EASTERN UNITED STATES, EXCLUSIVE OF FLORIDA, BASED IN PART ON LITERATURE)

- 1. Ventral surface of eyes with large portion narrowed and extending posteriad beyond the posterior margin of the dorsal part of the eye (Fig. 301).....2
- Ventral surface of eyes, for the most part, similar to dorsal aspect in shape or only extending posteriad beyond the dorsal part of the eye by one or two facets.....5
- 2. Prothorax yellow or orange-yellow.....3
- Prothorax brown, occasionally yellowish brown.....4
- 3. Antennal segment I largely brown; antennal segment III with an inner sense cone.....**bicolor**
- Antennal segment I orange-yellow; antennal segment III lacking an inner sense cone; not yet found in Illinois.....**gilvipes**
- 4. Antennal segment III yellow except for apex.....**dentipes**
- Antennal segment III yellow in pedicel, brown medially, and yellowish brown apically; not yet found in Illinois.....**litoreus**
- 5. Antennal segment I largely yellow; postocellar setae small; not yet found in Illinois.....**pratensis**
- Antennal segment I largely brown; postocellar setae moderate in size.....**icarus**

Nesothrips (Bolothrips) bicolor (Heeger)

Phloeothrips bicolor Heeger (1852:477). ? ♀. Type-locality.—Vienna, Austria. Transferred to *Cryptothrips* by Uzel (1895). Transferred to *Bolothrips* by Priesner (1926a). Transferred to *Nesothrips* by Stannard (1957b).

Oedaleothrips andrei Watson (1933a: 49). ♀, ♂. Type-locality.—Ames, Iowa. Synonymized by Hood (1936b).

FEMALE (apterous).—Length distended about 2.8 mm. Bicolored yellow and dark brown. Antennal segment II except at extreme base, segments III and IV, segment V except at apex, and segment VI in pedicel yellow to yellowish brown; segment I and most of VI medium brown. Prothorax and legs bright yellow. Head, remainder of antennae, pterothorax, and abdomen blackish brown, being darkest in head and tube.

Head (Fig. 301) slightly longer than wide, greatest width across eyes. Eyes

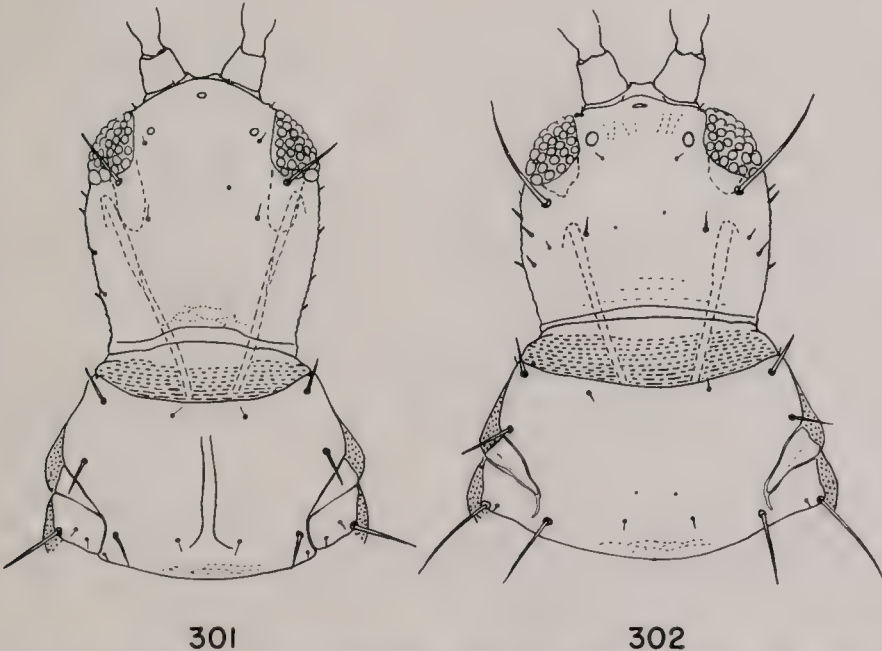


Fig. 301-302.—Head and prothorax: 301, *Nesothrips (Bolothrips) bicolor*; 302, *Nesothrips (Gastrothrips) ruficauda*.

prolonged ventrally. Ocelli present but reduced in size. Postocellar setae small; postocular setae well developed, pointed. Antennal segment III with one inner and one outer sense cone; segment VIII well separated from segment VII, slightly pedicellate.

Prothorax with all setae pointed; anteromarginal setae small, the remainder of the major setae well developed (Fig. 301). Pteronotum with sclerotized portion reduced, typical of apterous forms, without trace of basal wing sclerites. Metanotum smooth. Fore tarsi each unarmed.

Pelta as in Fig. 303. Wing-holding setae not differentiated. Tube (Fig. 299) about seven-tenths as long as head.

FEMALE (macropterous).—Length distended about 2.8 mm. Similar in general color and structure to apterous female. Pterothorax somewhat reduced, metanotum smooth. Wings fully developed, fore wings colorless except for scale and region just above scale, which are light gray. Fore wings broad with fringe cilia fairly close together, with 6–10 accessory fringe cilia.

MALE (apterous).—Length distended about 2.6 mm. Similar in color and structure to apterous female. Major form with fore legs and prothorax enlarged, fore tarsi each with a large well-developed tooth, fore tibiae each with a small inner apical tooth. Tube slightly more than half as long as head.

This species is easily distinguished by the bright yellow prothorax and legs in contrast to the black head, pterothorax, and abdomen. According to Dr. H. B. Mills (orally) this thrips, because of its striking color and attractive appearance, influenced Dean Floyd Andre, then a student at Ames, Iowa, to take up the study of Thysanoptera.

Hood (1914b) recorded *bicolor*, under *Cryptothrips*, as being introduced from Europe to North America as early as 1913. It was first discovered here by Dr. J. C. Faure, then also a student, at Canastota, New York. Since then it has been found scattered throughout the northern part of North



Fig. 303.—*Nesothrips bicolor*, pelta.

America. Its occurrence in Illinois is limited to the northern half of the state where it is found on native and naturalized grasses.

In the United States the macropterous form is very rare.

Illinois records (Fig. 16).—Collected every month of the year, from one to several localities in the following counties: CARROLL, CHAMPAIGN, DOUGLAS, HENDERSON, HENRY, IROQUOIS, JO DAVIESS, KANE, KENDALL, KNOX, LAKE, LA SALLE, LEE, MASON, MCLEAN, MCHENRY, OGLE, PIATT, ROCK ISLAND, STEPHENSON, WHITESIDE, WILL, WINNEBAGO, and WOODFORD.

Nesothrips* (*Bolothrips*) *dentipes (Reuter)

Phloeothrips dentipes Reuter (1885: 12). ♀. Type-locality.—Finland. Transferred to *Bolothrips* by Priesner (1928). Transferred to *Nesothrips* by Stannard (1957b).

FEMALE (apterous) (Fig. 304).—Length distended about 3.5 mm. Color generally dark brown. Antennal segment III in basal two-thirds, extreme base and apex of femora, inside of fore tibiae, and tarsi yellow to yellowish brown.

Head longer than broad, greatest width through eyes. Eyes prolonged ventrally. Ocelli present but reduced in size. Postocellar setae relatively small. Postocular setae well developed, long and pointed. Antennal segment III with one inner ventral sense cone and one outer sense cone, segment VIII well separated from segment VII but without a constricted pedicel.

Prothorax with all setae pointed; anterolateral, midlateral, and posteromarginal setae longer than in *gilvipes*; compare Hood (1914, plate V, Fig. 4) with Fig. 304. Pteronotum with scler-

rites reduced, typical of apterous condition, a few basal wing sclerites present; metanotum smooth. Fore tarsi unarmed.

Pelta about as in Fig. 303. Wing-

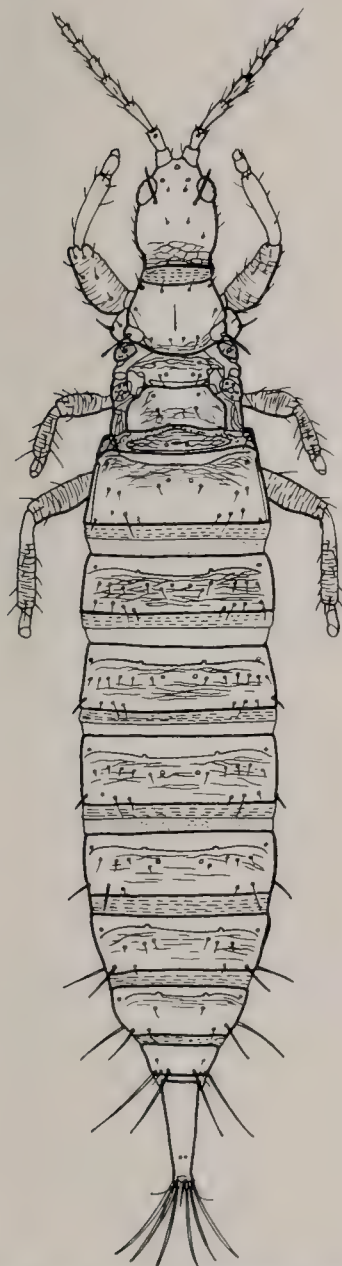


Fig. 304.—*Nesorhrips dentipes*, dorsal aspect.

holding setae not differentiated. Tube long, about nine-tenths as long as head.

MALE (apterous).—Length distended about 3 mm. General color and structure similar to female. Major forms with fore legs greatly enlarged, fore tarsi each with a strongly developed tooth, fore tibiae at each inner apex with a small tooth. Tube about three-fourths as long as head.

This entity appears to be very similar to *litoreus* Hood. Aside from a few minor differences in color, i.e. color of antennal segment III and base of head, *dentipes* differs from *litoreus* mostly in being slightly longer and in having a slightly longer tube.

So far this species has been found only in marshy areas. In Illinois it has never been taken outside of Lake County.

Illinois records.—LAKE COUNTY: Beach St. Park, Zion, July 27, 1960, Smith, Ross, Cunningham, on *Carex*, 1 ♀; Wauconda, October 28, 1943, Ross, Sanderson, in tamarack bog, 1 ♂; Fox Lake, June 7, 1950, Sanderson, Benjamin, sweeping, 1 ♀; Fish Lake, September 12, 1951, Richards, Stannard, sweeping along shore, 1 ♀; Antioch, October 15, 1942, Ross, Sanderson, in mammal's nest by tamarack bog, 1 ♀.

***Nesorhrips (Bolothrips) icarus* (Uzel),
new combination**

Cryptothrips Icarus [sic] Uzel (1895: 232). ♀, ♂. Type-locality.—Bohemia (Czechoslovakia). Transferred to *Bolothrips* by Priesner (1938).

FEMALE (apterous).—Length distended about 2.3 mm. General color dark brown. Joints of legs and tarsi yellow. Antennal segment I at base, segment II at apex, segment IV in basal half, and pedicel of segment V yellowish brown; segment III yellow; remainder of antennae brown. Brown portions of legs generally in lighter shades.

Head much longer than wide. Eyes slightly bulged from head, hardly at all prolonged ventrally. Fore ocellus

present, hind ocelli absent. Postocular setae moderately developed. Postocular setae well developed, pointed. Antennal segment III with one inner and one outer sense cone; segment VIII well separated from segment VII, slightly pedicellate.

Prothorax with all setae pointed to blunt, anterior setae small, the remainder of the major setae well developed. Pterothorax reduced; metanotum smooth. Fore tarsi unarmed.

Pelta similar to Fig. 303. Wing-holding setae not differentiated. Tube nearly three-fifths as long as head.

MALE (apterous).—Length distended about 2 mm. Similar to female in general color and structure except legs usually entirely bright yellow. Fore ocellus present, posterior ocelli lacking in specimens from Michigan, present in specimen I have seen from Czechoslovakia. Major forms with fore legs greatly enlarged, fore tarsi each armed with a large tooth, fore tibiae with a small tooth at inner apical angle.

This species is recorded here for the first time in North America. The specimens examined came from the George Reserve near Pinckney, Michigan. They were collected in 1956 by R. B. Root from nests of vesper and field sparrows.

So far *icarus* has not been found in Illinois but its presence is expected.

Nesothrips subgenus *Gastrothrips* Hood

Gastrothrips Hood (1912c:156). Type-species by original designation.—*Gastrothrips ruficauda* Hood. Subordinated under *Nesothrips* by Stannard (1957b).

As pertains to the Illinois fauna:

Head more or less oval, at the most only slightly prolonged anteriorly of the eyes. Cheeks without strong setae. Eyes relatively small, ventral surface slightly extended posteriorly more than on dorsal surface. Ocelli present, reduced in size. Postocular setae small. Postocular setae well developed, pointed. Antennae eight segmented,

intermediate segments only slightly elongate, segment VIII well separated from segment VII. Mouth cone broadly rounded. Maxillary stylets, when retracted, placed V-shaped within the head.

Prothorax with all major setae well developed except anteromarginal pair which are relatively small. Epimeral sutures usually complete or nearly so (incomplete in specimens I have seen of an undetermined species from Florida). Praepectus well developed. Fore legs unarmed in female, usually armed in male. Males with a toothlike projection anterior to each mesothoracic spiracle. Macropterous or apterous. Fore wings when present with or without accessory fringe cilia.

Abdominal segment I with a fairly broad pelta, usually reticulate. Tube (Fig. 300) moderate in size to small, often slightly thickened, usually slightly constricted at apex.

In Illinois, but not in some other parts of the world, species of the subgenus *Gastrothrips* are easily distinguished from those in the subgenus *Bolothrips*. The orange color of the tube of the single Illinois species of *Gastrothrips*, *ruficauda*, will differentiate this entity from *Bolothrips*. In addition, in *Gastrothrips* body projections, such as toothlike spines on various parts of the thorax, often appear on males. No such tendency to bear thoracic spines has been observed in *Bolothrips*.

Nesothrips* (*Gastrothrips*) *ruficauda Hood

Gastrothrips ruficauda Hood (1912c:156). ♀. Type-locality.—Not stated, but holotype labeled Grand Tower, Illinois. Transferred to *Nesothrips* by Stannard (1957b).

FEMALE (apterous).—Length distended about 2 mm. General color dark brown. Inner apical angles of all femora, tibiae, apex of antennal segment II, and pedicel of segment III yellowish brown to yellow. Tube orange-brown except at extreme base and apex which are dark brown. Setae

generally brown, epimeral setae sometimes brown at base and white at tip.

Head (Fig. 302) slightly wider than long, generally smooth. Eyes small, prolonged on the venter slightly more than on the dorsum. Ocelli present, but reduced in size. Postocellar setae small. Postocular setae long, pointed. Antennal segment III with no inner and one outer sense cone; segment VIII with base narrowed, not closely joined to segment VII.

Prothorax with all major setae except the anteromarginal setae well developed and pointed, the epimeral setae being the largest. Epimeral sutures complete. Pterothorax reduced. Metanotum smooth. Fore legs unarmed.

Pelta broad. Wing-holding setae not differentiated. Abdominal segment IX with major posterior setae slightly shorter than length of tube. Tube (Fig. 300) short, slightly thickened, abruptly constricted at apex, with short terminal setae.

FEMALE (macropterous).—Unknown.

MALE (apterous).—Length distended about 1.6 mm. Similar to female in general color. Fore legs usually slightly enlarged, fore tarsi each with a strongly developed tooth. Lateral angles of mesonotum, just above spiracles, each with a toothlike projection.

This species can be easily recognized by the slightly thickened, nearly orange tube. Like *Illinothrips rossi*, the male of *ruficauda* bears a toothlike projection anterior of each mesothoracic spiracle.

So far *ruficauda* has been found only in the southern half of the state. Mostly it has been collected from dead willow twigs although many other tree twigs have been found to harbor specimens. Once I jarred a series of females from Hydraceae fungi growing on dead hickory branches.

Illinois records.—Collected from April through October, from one to several localities in the following counties; COLES, CRAWFORD, CUMBERLAND, EFFINGHAM, GALLATIN, HAMILTON, JACKSON (Hood 1912c), MARION, POPE, PULASKI (Hood 1912c), UNION, and WABASH.

Oedaleothrips Hood

Oedaleothrips Hood (1916b:64). Type-species by original designation.—*Oedaleothrips hookeri* Hood.

Myrmecothrips Watson (1920:20). Type-species by original designation.—*Myrmecothrips querci* Watson. Synonymized by Watson (1924a).

Myrmecothrips Priesner (1925e:485). Type-species by original designation.—*Myrmecothrips dampfi* Priesner. Preoccupied by *Myrmecothrips* Watson, synonymized by Hood (1936b).

Formicothrips Priesner (1927:479). New name for *Myrmecothrips* Priesner.

Head longer than wide, swollen except for base which is abruptly narrowed. Eyes on the venter ordinarily prolonged posteriorly more than on the dorsum. Ocelli absent. Postocular setae well developed. Antennae eight segmented, segment III moderately elongate, segments V and VI prolonged ventrally at apex. Mouth cone broadly rounded. Maxillary stylets when retracted into the head placed far apart, often V shaped.

Prothorax small relative to the head, pterothorax exceptionally small compared to head and abdomen. All major prothoracic setae well developed. Metanotum (Fig. 305) raised (similar to the scale of the petiole of an ant), often concentrically striate (Fig. 306). Praepectus present. Mesopraesternum well developed, extremely narrow. Apterous in North America. Fore tarsi armed in both sexes.

Pelta broad. Abdominal tergite II long, often strongly sculptured. Wing-holding setae not differentiated. Tube moderate in size.

This genus is easily recognized in North America by the characteristics of the swollen head and the small size of the pterothorax which in profile resembles the scale of the petiole of an ant.

Only one species, *hookeri*, occurs in our state.



Fig. 305.—*Oedaleothrips* species, lateral aspect, showing ant-mimicing form.

Oedaleothrips hookeri Hood

Oedaleothrips hookeri (1916b:64). ♀.

Type-locality.—Dallas, Texas.

Oedaleothrips campestris Hood (1941:190). ♀, ♂. Type-locality.—El Campo, Texas. New synonymy.

FEMALE (apterous).—Length distended nearly 3 mm. Color predominantly dark blackish brown. Antennal segments I and II light yellow becoming yellowish brown in segment III. Tube yellow to yellowish tan except tip which is brown. Anterior of pelta, an anterior spot on each side of abdominal segment II, and a spot on each side of abdominal segment V white. Body setae colorless.

Head bulged, sharply constricted at neck, hexagonally reticulate at base. Eyes prolonged ventrally much as in *Nesothrips* (*Bolothrips*) *bicolor*. Post-ocular setae dilated. Antennal segment III with one inner and one outer sense cone, segment VIII constricted at base, pedicellate.

Prothorax with longitudinal striations confined to the lateral margins, major setae dilated. Metanotum (Fig. 306) with some concentric rings completely encircling the raised median portion. Fore tarsi each armed with a small tooth.

Abdominal tergite IX with posterior setae dilated, the lateral pair nearly as long as tube. Tube constricted at apex.

MALE (apterous).—Unknown to

me. Probably similar to female in most respects.

All the specimens I have seen—which are from Illinois, Oklahoma, and Arkansas—could be assigned to either *hookeri* or to *campestris*, being intermediate to the two. Considering that some color variation might well occur in a wide-ranging species, I believe it is reasonable to sink *campestris* under *hookeri*. Certainly Hood did not present much evidence that the two were different species. He stated that they “may be separated by certain details of coloration and by the form of the tube.” The holotype of *hookeri* is a broken specimen with a partially telescoped abdomen. It differs only slightly from the holotype of *campestris* as far as can be seen.

Specimens from Illinois are known

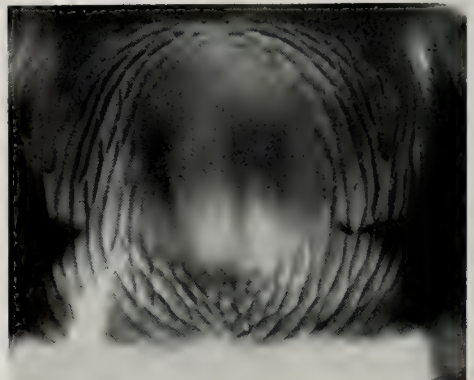


Fig. 306.—*Oedaleothrips hookeri*, part of metathorax showing striations. Photo by J. D. Maddox.

only from the Ozark regions in the southwestern tip of our state up to Pere Marquette State Park. They have been taken from hill prairies. Probably they feed on fungus spores (Fig. 307).

(Pine Hills), April 9, 1953, Stannard, hill prairie, 7 ♀.

Pygidiothrips Hood

Pygidiothrips Hood (1938c:389).

Type-species by original designation.—*Pygidiothrips seminole* Hood.

Body minute, generally degenerate, stout.

Head small, about as broad as long, widest at cheeks just behind eyes, surface smooth. Eyes relatively small with about a dozen dorsal facets and less than a half dozen ventral facets. Ocelli absent in apterous forms. Postocular setae well developed, dilated. Antennae (Fig. 161) six segmented, segment III smallest, segment VI largest, being composed of fused morphological segments VI–VIII. Mouth cone broadly rounded, nearly equal in length to dorsal length of head. Maxillary stylets broad, retracted into the head to the region of the eyes, widely spaced within the head.

Prothorax smooth, anteromarginal and midlateral setae minute, anterolateral and posterior setae well developed, dilated. Praepectus seemingly absent. Meso- and metanotum smooth, degenerate, reduced to simple transverse plates. Apterous in specimens so far collected. Thoracic sternites much reduced. Metafurca placed anteriorly touching mesofurca. Legs short, mid and hind tarsi two segmented, each segment separated by a weak suture.

Pelta almost lost, mostly broken into tiny stipple-like platelets. Wing-holding setae absent, major abdominal setae dilated. Abdominal tergite IX with four pairs of stout, thornlike setae in addition to regular setae. Abdominal segment X (tube) short, stout, ridged, and sharply constricted at apex. Anal setae small, shorter than tube length.

This monobasic genus resembles *Allothrips* and its allies. It is one of the smallest representatives of the Megathripinae and can be easily recognized by the short, stout, ridged tube and ring of thornlike setae on abdominal tergite IX.



Fig. 307.—*Oedaleothrips* species, larva showing gut filled with fungus spores. Photo by Wilmer Zehr.

Illinois records.—JACKSON COUNTY: Murphysboro (Little Grand Canyon Area), September 23, 1953, Ross, Evers, hill prairie, 1 ♀. JERSEY COUNTY: Pere Marquette State Park, November 20, 1958, Stannard, hill prairie, 1 ♀. UNION COUNTY: Wolf Lake

***Pygidiothrips seminole* Hood**

Pygidiothrips seminole Hood (1938c: 390). ♀. Type-locality.—Homestead, Florida.

FEMALE (apterous).—Length distended about 0.9 mm. General color brown with antennal segment I and intermediate abdominal segments lightest, and abdominal segments VIII and IX darkest. Antennal segment II pale yellowish white. Tube brown at base and apex, bright yellow medially. Subintegumental pigment bright red. Body setae colorless, ringlet of thornlike setae on abdominal tergite IX brown.

Head as in Fig. 308 with cheeks smooth. Antennal segment III extremely short and without sense cones, segment IV with one inner and one outer sense cone.

Prothorax smooth. Anterior and posterior margins degenerate, becoming largely fractured into stipple-like platelets. Epimeral sutures incomplete. Meso- and metanotum smooth. Fore legs unarmed.

Pelta mostly stippled, with only traces of smooth, evenly sclerotized sections. Abdominal sternites seemingly without median setae in addi-

tion to posterior pairs. Abdominal tergite IX with major posterior setae longer than tube, blunt to dilated; thornlike setae short, all nearly equal in size. Tube strongly ridged at base.

MALE.—Unknown.

This is the only species in the genus. From the other species in the eastern United States which have antennal segment III exceptionally small, *seminole* can be distinguished by the shape of the tube, the six-segmented antennae, and the ringlet of thornlike setae on abdominal tergite IX.

Pygidiothrips seminole occurs from Homestead, Florida to Brownsville, Texas (USNM records), being found so far on dead branches. The possibility of this species inhabiting Illinois is somewhat remote.

***Sporothrips* Hood**

Sporothrips Hood (1938c:410). Type-species by original designation.—*Adiaphorothrips amplus* Hood.

Head much longer than broad, widest in basal one-third region, slightly prolonged anteriorly in front of eyes, sharply incised just before base. Eyes relatively small, length less than combined length of antennal segments I and II. Ocelli present. Postocellar setae not greatly enlarged. Postocular setae well developed. Middle pair of dorsal head setae small. Antennae eight segmented, segment III more than twice as long as II, segment VIII nonpedicellate, sense cones short. Mouth cone broadly rounded. Maxillary stylets broad, retracted about one-half way into the head, spaced fairly far apart within the head.

Prothorax moderately long in female, longer in male, with major anterior setae shorter than the better-developed major posterior setae. Praepectus present. Prothoracic epimeral sutures complete. Mesopraesternum (Fig. 194) well developed and wide. Macropterous. Fore wings broad, with many accessory fringe cilia. Fore legs not enlarged in female, enlarged in male, armed in both sexes. Fore tibiae in male each with an inner apical tooth in addition to the tarsal tooth.

Abdomen fairly broad. Pelta wide.

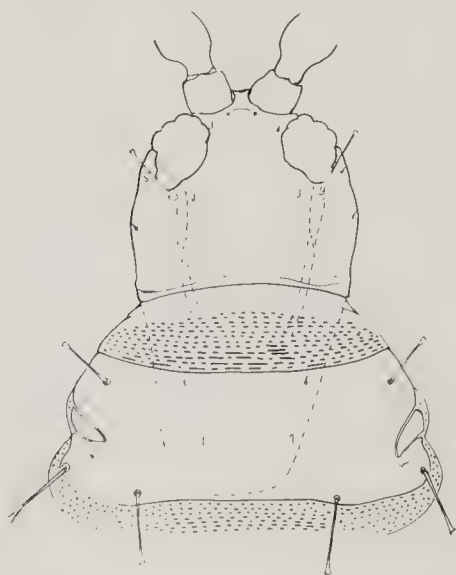


Fig. 308. *Pygidiothrips seminole*, head and prothorax.

Wing-holding setae usually straight, not sigmoidal. Abdominal tergite IX with major posterior setae long in both sexes. Abdominal segment X (tube) long, about three-fourths as long as head; anal setae shorter than tube.

All major body setae pointed.

This monobasic genus can be recognized by the form of the head, in which the eyes are relatively small and the cheeks swollen in the basal third followed immediately by a sharply incised subbasal region, as well as by the armature of the fore legs of the male.

So far the representative of this genus, *amplus*, has been collected only in southern Florida and may never be found in Illinois.

Sporothrips amplus (Hood)

Adiaphorothrips amplus Hood (1925c: 221). ♀. Type-locality.—Bradenton, Florida. Transferred to *Sporothrips* by Hood (1938c).

FEMALE (macropterous).—Length distended about 4 mm. General color brown, being darkest in abdomen. Base of tibiae and all tarsi light brown to yellowish brown. Antennal segment III mostly, and bases of segments IV and V yellow. Body setae yellow. Wings colorless.

Head as in Fig. 178, with sides transversely striate, base hexagonally reticulate, cheek setae small. Antennal segment III with one outer and one inner sense cone, segment IV with two outer and two inner sense cones.

Prothorax weakly hexagonally reticulate, bare medially. Metascutum hexagonally reticulate. Fore tibiae without inner apical tooth, fore tarsi each armed with a moderate-sized tooth. Fore wings broad, with more than 30 accessory fringe cilia.

Pelta (Fig. 309) wide, predominantly hexagonally reticulate. Abdominal sternites with a median row of small setae in addition to posterior pairs.

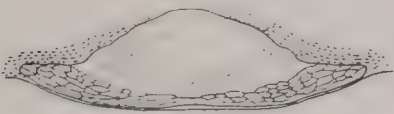


Fig. 309. —*Sporothrips amplus*, pelta.

Abdominal tergite IX with major posterior setae not as long as tube. Abdominal segment X (tube) very faintly hexagonally reticulate except at apex.

MALE (macropterous).—Length distended about 3.5 mm. Similar in general color and structure to female with the following exceptions. Antennal segment VI often yellow basally. Prothorax enlarged. Fore femora greatly enlarged. Fore tibiae each with inner apical tooth. Fore tarsi (Fig. 310) each with a very large tooth that is about twice as long as width of tarsus that bears it.

This species, the sole representative of the genus, is allied to the *Nesothrips-Diceratothrips* complexes. From thrips in the North American fauna, it can be distinguished by the characteristics of the shape of the head and the armature of the fore legs of the male.

As is implied in its generic name, great quantities of fungus spores are ordinarily found in its intestinal tract.

Specimens have been taken from dead branches and dead leaves of palms where black fungus growths are frequently found. The few collections known are from southern Florida, including Big Pine Key (INHS records).



Fig. 310.—*Sporothrips amplus*, ♂, right fore leg showing claws.

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- Volume 27, Article 6.—Sex Ratios and Age Ratios in North American Ducks. By Frank C. Bellrose, Thomas G. Scott, Arthur S. Hawkins, and Jessop B. Low. August, 1961. 84 p., 2 frontis., 32 fig., bibliogr.
- Volume 28, Article 2.—The Fishes of Champaign County, Illinois, as Affected by 60 Years of Stream Changes. By R. Weldon Larimore and Philip W. Smith. March 1963. 84 p., frontis., 70 fig., bibliogr., index.
- Volume 28, Article 3.—A Comparative Study of Bird Populations in Illinois, 1906–1909 and 1956–1958. By Richard R. Graber and Jean W. Graber. October, 1963. 146 p., 4 frontis., 32 fig., bibliogr., index.
- Volume 29, Article 1.—A Biological Investigation of the Fishes of Lake Chautauqua, Illinois. By William C. Starrett and Arnold W. Fritz. March, 1965. 104 p., frontis., 40 fig., bibliogr., index.
- Volume 29, Article 2.—Stocking and Sport Fishing at Lake Glendale (Illinois). By Donald F. Hansen. July, 1966. 54 p., frontis., 9 fig., bibliogr., index.
- Volume 29, Article 3.—Hybridization of Four Species of Sunfishes (Centrarchidae). By William F. Childers. September, 1967. 55 p., frontis., 2 fig., color plate, bibliogr., index.

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LENGTH-WEIGHT RELATIONSHIP DATA

FOR 11 SPECIES OF FISH IN LAKE CHAUTAUQUA

S U P P L E M E N T A R Y T A B L E S

FOR

A BIOLOGICAL INVESTIGATION OF THE

FISHES OF LAKE CHAUTAUQUA, ILLINOIS

by William C. Starrett and Arnold W. Fritz

ILLINOIS NATURAL HISTORY SURVEY BULLETIN

Volume 29, Article 1, pages 1-104

Published by the

State of Illinois

Department of Registration and Education

Natural History Survey Division

Urbana, Illinois

March, 1965

These tables are referred to on page 7 in the section entitled "Calculations."

Supplementary Table 1.--Average and range of calculated weights (at various lengths) of 2,651 bluegills taken at Lake Chautauqua, Illinois (fall months, 1950-1959).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
5.0	0.10	0.08 to 0.11
5.5	0.14	0.11 to 0.16
6.0	0.18	0.16 to 0.21
6.5	0.24	0.21 to 0.27
7.0	0.31	0.27 to 0.34
7.5	0.38	0.34 to 0.43
8.0	0.48	0.42 to 0.54
8.5	0.58	0.52 to 0.61
9.0	0.70	0.70 to 0.75

* Average calculated $\log W = -1.31249 + 3.31026 (\log L)$.

Supplementary Table 2.--Average and range of calculated weights (at various lengths) of 7,739 white crappies taken at Lake Chautauqua, Illinois (September and early October, 1950-1959).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
6.0	0.10	0.09 to 0.11
6.5	0.13	0.11 to 0.14
7.0	0.17	0.15 to 0.19
7.5	0.21	0.19 to 0.24
8.0	0.26	0.24 to 0.29
8.5	0.32	0.30 to 0.35
9.0	0.39	0.36 to 0.42
9.5	0.46	0.44 to 0.50
10.0	0.55	0.52 to 0.60
10.5	0.64	0.61 to 0.71
11.0	0.75	0.71 to 0.83
11.5	0.86	0.82 to 0.96
12.0	0.99	0.94 to 1.01

* Average calculated $\log W = -1.53658 + 3.27432 (\log L)$.

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Supplementary Table 3.--Average and range of calculated weights (at various lengths) of 3,985 black crappies taken at Lake Chautauqua, Illinois (September and early October, 1950-1959).

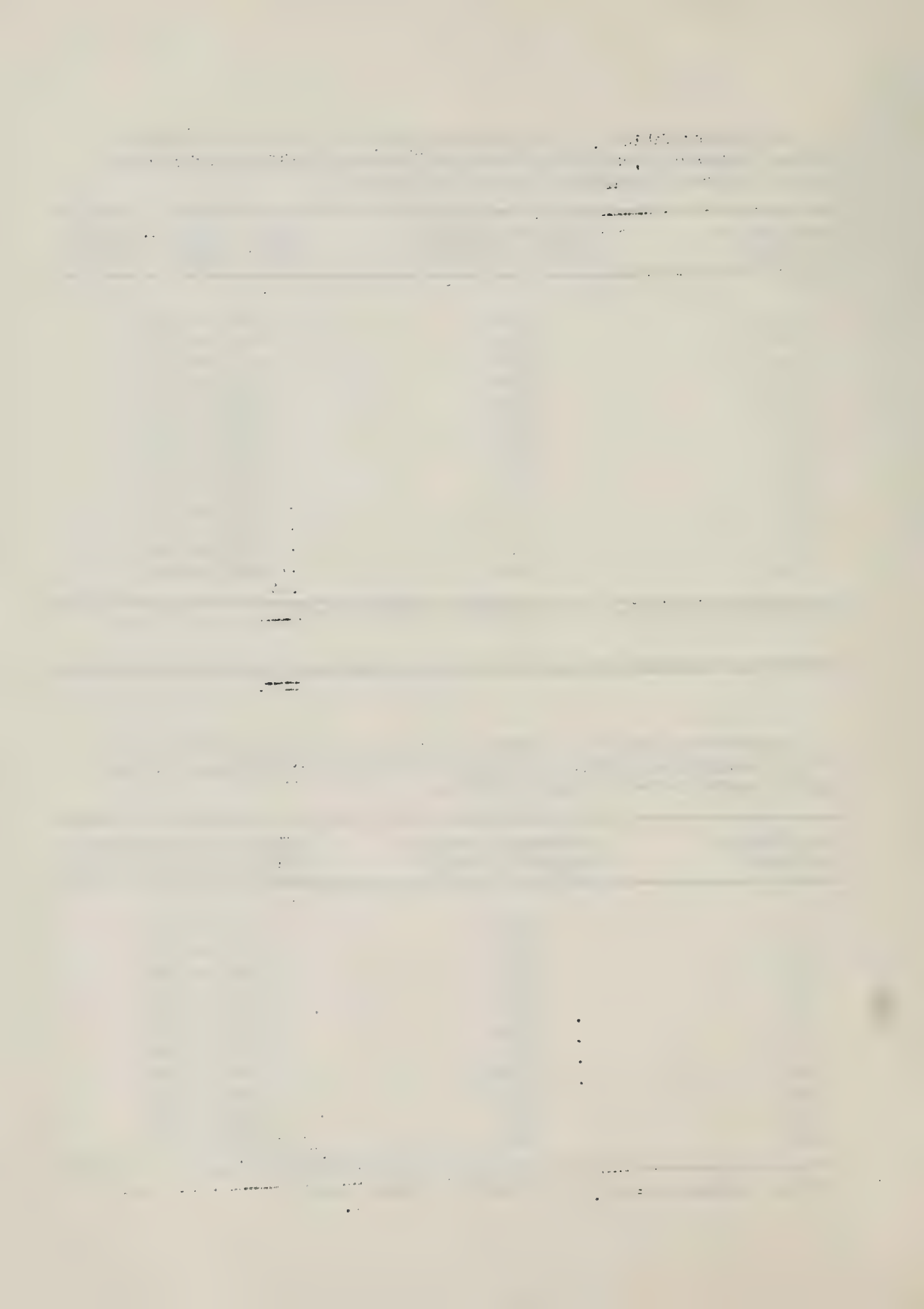
Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
5.5	0.09	0.08 to 0.09
6.0	0.12	0.10 to 0.13
6.5	0.15	0.13 to 0.16
7.0	0.19	0.17 to 0.22
7.5	0.24	0.22 to 0.27
8.0	0.29	0.27 to 0.32
8.5	0.36	0.34 to 0.39
9.0	0.43	0.41 to 0.46
9.5	0.51	0.49 to 0.55
10.0	0.60	0.57 to 0.65
10.5	0.70	0.67 to 0.76
11.0	0.81	0.78 to 0.88
11.5	0.94	0.85 to 0.96

*Average calculated $\log W = -1.42138 + 3.19958 (\log L)$.

Supplementary Table 4.--Average and range of calculated weights (at various lengths) of 2,091 yellow bass taken at Lake Chautauqua, Illinois (spring months 1950-1954 and 1957-1959).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
6.5	0.14	0.11 to 0.16
7.0	0.17	0.14 to 0.20
7.5	0.21	0.18 to 0.24
8.0	0.26	0.23 to 0.29
8.5	0.32	0.29 to 0.35
9.0	0.38	0.35 to 0.41
9.5	0.45	0.41 to 0.48
10.0	0.53	0.48 to 0.56
10.5	0.62	0.56 to 0.65
11.0	0.71	0.65 to 0.75
11.5	0.82	0.74 to 0.85

*Average calculated $\log W = -2.42004 + 3.14296 (\log L)$.



Supplementary Table 5.--Calculated weights (at various lengths) of 582 largemouth bass taken in the spring and fall months at Lake Chautauqua, Illinois (1950-1959).

Total Length in Inches	Calculated Weight in Pounds*	Number of Fish
6.0	0.11	4
6.5	0.14	13
7.0	0.18	8
7.5	0.22	17
8.0	0.27	22
8.5	0.32	34
9.0	0.38	40
9.5	0.45	47
10.0	0.53	61
10.5	0.62	38
11.0	0.71	55
11.5	0.81	32
12.0	0.93	42
12.5	1.05	20
13.0	1.19	26
13.5	1.33	34
14.0	1.49	17
14.5	1.66	19
15.0	1.84	12
15.5	2.04	6
16.0	2.25	7
16.5	2.47	5
17.0	2.71	8
17.5	2.96	3
18.0	3.23	5
18.5	3.51	3
19.0	3.81	2
19.5	4.12	1
20.0	4.46	1

*Average calculated $\log W = -2.34869 + 3.07281 (\log L)$.

Supplementary Table 6.--Calculated weights (at various lengths) of 1,094 white bass taken in the spring and fall months at Lake Chautauqua, Illinois (1950-1959).

Total Length in Inches	Calculated Weight in Pounds*	Number of Fish
4.5	0.03	1
5.0	0.05	18
5.5	0.07	90
6.0	0.09	89
6.5	0.11	42
7.0	0.15	33
7.5	0.18	24
8.0	0.23	39
8.5	0.28	21
9.0	0.34	4
9.5	0.41	1
10.0	0.48	14
10.5	0.57	51
11.0	0.66	99
11.5	0.77	136
12.0	0.88	118
12.5	1.01	68
13.0	1.15	70
13.5	1.31	59
14.0	1.48	48
14.5	1.66	36
15.0	1.86	17
15.5	2.07	9
16.0	2.30	7

*Average calculated $\log W = -2.34869 + 3.07281 (\log L)$.

Supplementary Table 7.--Average and range of calculated weights (at various lengths) of 2,882 freshwater drum taken at Lake Chautauqua, Illinois (September, 1951-1958).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
9.0	0.34	0.31 to 0.36
9.5	0.40	0.36 to 0.43
10.0	0.47	0.42 to 0.50
10.5	0.54	0.49 to 0.59
11.0	0.63	0.56 to 0.68
11.5	0.72	0.64 to 0.78
12.0	0.82	0.73 to 0.88
12.5	0.92	0.82 to 1.00
13.0	1.04	0.92 to 1.13
13.5	1.17	1.03 to 1.26
14.0	1.30	1.15 to 1.41
14.5	1.45	1.28 to 1.58
15.0	1.60	1.41 to 1.75
15.5	1.77	1.55 to 1.94
16.0	1.95	1.69 to 2.14
16.5	2.14	1.84 to 2.35
17.0	2.34	1.99 to 2.57
17.5	2.56	2.16 to 2.82
18.0	2.79	2.79 to 3.00

*Average calculated $\log W = -2.36175 + 2.98633 (\log L)$.

Supplementary Table 8.--Average and range of calculated weights (at various lengths) of 2,471 bigmouth buffalo taken at Lake Chautauqua, Illinois (September 1951-1952).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
16.0	2.46	2.39 to 2.57
16.5	2.72	2.65 to 2.84
17.0	3.00	2.92 to 3.12
17.5	3.29	3.20 to 3.48
18.0	3.61	3.51 to 3.75
18.5	3.94	3.84 to 4.10
19.0	4.30	4.19 to 4.47
19.5	4.68	4.56 to 4.86
20.0	5.08	4.96 to 5.27
20.5	5.51	5.36 to 5.71
21.0	5.96	5.78 to 6.17
21.5	6.43	6.22 to 6.66
22.0	6.93	6.69 to 7.18
22.5	7.45	7.18 to 7.72
23.0	8.00	7.69 to 8.28
23.5	8.58	8.23 to 8.88
24.0	9.19	8.79 to 9.50
24.5	9.83	9.38 to 10.16
25.0	10.50	9.99 to 10.84
25.5	11.20	10.64 to 11.59
26.0	11.92	11.31 to 12.31

*Average calculated $\log W = -3.52421 + 3.25141 (\log L)$.

Supplementary Table 9.--Average and range of calculated weights (at various lengths) of 2,481 channel catfish taken at Lake Chautauqua, Illinois (September, 1951-1958).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calculated Weights in Pounds
12.0	0.49	0.47 to 0.50
12.5	0.57	0.55 to 0.60
13.0	0.65	0.63 to 0.68
13.5	0.74	0.71 to 0.77
14.0	0.84	0.81 to 0.87
14.5	0.95	0.92 to 1.00
15.0	1.07	1.03 to 1.14
15.5	1.19	1.16 to 1.25
16.0	1.33	1.29 to 1.38
16.5	1.48	1.44 to 1.53
17.0	1.64	1.60 to 1.69
17.5	1.81	1.77 to 1.87
18.0	1.99	1.95 to 2.06
18.5	2.19	2.13 to 2.27
19.0	2.40	2.33 to 2.49
19.5	2.63	2.54 to 2.72
20.0	2.87	2.77 to 2.97
20.5	3.12	3.01 to 3.24
21.0	3.39	3.26 to 3.53
21.5	3.68	3.53 to 3.82
22.0	3.98	3.81 to 4.15
22.5	4.30	4.10 to 4.49
23.0	4.64	4.42 to 4.85
23.5	4.99	4.75 to 5.23
24.0	5.37	5.09 to 5.68
24.5	5.76	5.46 to 6.05
25.0	6.18	5.84 to 6.50
25.5	6.61	6.31 to 6.96
26.0	7.07	6.73 to 7.45
26.5	7.56	7.18 to 7.99
27.0	8.05	7.62 to 8.51
27.5	8.57	8.10 to 9.07
28.0	9.12	8.60 to 9.66

* Average calculated $\log W = -3.01994 + 3.44126 (\log L)$.

Supplementary Table 10.--Average and range of calculated weights (at various lengths) of 2,479 carp taken at Lake Chautauqua, Illinois (September, 1951-1958).

Total Length in Inches	Calculated Average Weight in Pounds*	Range of Annual Calcu- lated Weights in Pounds
15.0	1.67	1.57 to 1.74
15.5	1.84	1.73 to 1.92
16.0	2.03	1.91 to 2.11
16.5	2.23	2.05 to 2.34
17.0	2.44	2.29 to 2.57
17.5	2.67	2.50 to 2.82
18.0	2.91	2.73 to 3.09
18.5	3.16	2.96 to 3.37
19.0	3.43	3.21 to 3.67
19.5	3.71	3.47 to 3.99
20.0	4.01	3.75 to 4.32
20.5	4.33	4.04 to 4.68
21.0	4.66	4.35 to 5.06
21.5	5.00	4.67 to 5.45
22.0	5.37	5.00 to 5.87
22.5	5.75	5.35 to 6.31
23.0	6.14	5.72 to 6.77
23.5	6.56	6.11 to 7.25
24.0	7.00	6.50 to 7.75
24.5	7.45	6.90 to 8.28
25.0	7.92	7.31 to 8.84
25.5	8.42	7.74 to 9.42
26.0	8.93	8.18 to 10.02
26.5	9.47	8.64 to 10.65
27.0	10.02	9.12 to 11.31
27.5	10.60	9.62 to 11.99
28.0	11.19	10.13 to 12.71

* Average calculated $\log W = -3.36498 + 3.05012 (\log L)$.

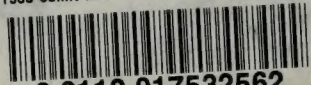
Supplementary Table 11. Average and range of calculated weights (at various lengths) of 1.0% glassed and taken at Lake Champlain, Illinois (September and early October of 1950 and 1951-1952).

Total length in inches	Calculated Average Weight in Pounds*	Range of Annual Calcu- lated Weights in Pounds
8.0	0.16	0.12 to 0.17
8.5	0.19	0.12 to 0.21
9.0	0.22	0.15 to 0.23
9.5	0.27	0.24 to 0.29
10.0	0.31	0.25 to 0.34
10.5	0.36	0.24 to 0.40
11.0	0.42	0.32 to 0.46
11.5	0.48	0.42 to 0.53
12.0	0.55	0.45 to 0.61
12.5	0.62	0.52 to 0.69
13.0	0.70	0.59 to 0.80
13.5	0.79	0.65 to 0.92
14.0	0.88	0.71 to 1.02
14.5	0.98	0.78 to 1.08
15.0	1.09	0.92 to 1.20
15.5	1.21	0.97 to 1.31
16.0	1.33	1.06 to 1.47

Average calculated log W = -2.3943 + 0.0004 (log L).

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